

**THE ROYAL INSTITUTION  
LIBRARY OF SCIENCE**

**PHYSICAL SCIENCES**

**Index Volume**

THE ROYAL INSTITUTION  
LIBRARY OF SCIENCE

# PHYSICAL SCIENCES

RETRO CONVERTED

B. C. S. C. L.

Index Volume

b.L = 3882  
REFERENCE

EDITED BY

SIR WILLIAM LAWRENCE BRAGG

(C.H., O.B.E., M.C., F.R.S., M.A. (Cantab))

Professor Emeritus and formerly Director of the  
Royal Institution of Great Britain and Fullerton Professor of Chemistry

AND

PROFESSOR GEORGE PORTER

F.R.S., M.A., Sc.D. (Cantab)

Director of the Royal Institution of Great Britain and  
Fullerton Professor of Chemistry

Ref 3882



ELSEVIER PUBLISHING COMPANY LTD

ELSEVIER PUBLISHING COMPANY LIMITED

BARKING, ESSEX, ENGLAND

ELSEVIER PUBLISHING COMPANY

335 JAN VAN GALENSTRAAT, P.O. BOX 211, AMSTERDAM

THE NETHERLANDS

AMERICAN ELSEVIER PUBLISHING COMPANY INC.

52 VANDERBILT AVENUE, NEW YORK, N.Y. 10017

ELSEVIER PUBLISHING COMPANY LIMITED

444 20048-7

LIBRARY OF CONGRESS CATALOG CARD NUMBER 70-95326

Printed by Page Bros. (Norwich) Ltd., Norwich

## PUBLISHER'S ANNOUNCEMENT

With the publication of this index volume the *Physical Sciences* volumes of the Royal Institution Library of Science is brought to completion. Since the publication of the main volumes the work has been acknowledged as an authority amongst scientific publications and the publishers confidently believe that this comprehensive index will form a fitting conclusion to the text volumes.

As the text volumes are arranged in chronological order it was felt that to aid the reader to turn to specific subjects with ease a comprehensive index would be necessary.

*Errata*—It is regretted that due to an unfortunate mischance pages 99 and 125 in Volume 5 were transposed. This error was also reflected in the contents page where the two page numbers were again transposed.





# INDEX

The figures in bold type indicate volume numbers

## A

- A.C. electrical supply, **4**, 97
  - high frequency, **4**, 167-182; **5**, 501
  - magnet, **8**, 489-501
  - sound from, **4**, 168
  - superconductivity, **9**, 429
- Abbé refractometer, **6**, 166
- Abel's fuse, **4**, 332
- Abenie acid, **1**, 206
- Aberration, **1**, 122; **4**, 189-200; **5**, 325; **8**, 101
  - chromatic, **1**, 122
  - spherical, **1**, 122
  - stellar, **4**, 195
- Absolute measurement of resistance, **4**, 426-446
  - motion, **10**, 301-331
  - ohm, **4**, 426-446; **6**, 361
  - refractive power, **6**, 154
  - scale of temperature, **6**, 349
  - unit, **4**, 427-430
  - velocities, **8**, 101-102
  - zero, **4**, 161, 223, 259-259; **5**, 459; **6**, 8-9, 381-390; **10**, 71-98
    - approach to, **4**, 161, 223; **5**, 459; **10**, 71-98
  - conduction at, **4**, 258-259, 529-530
  - molecular volumes, **6**, 8-9
  - Peltier effect, **4**, 258-259
- Absorption and emission, **1**, 350-351, 382-383; **3**, 63, 272
  - blackened surface, by, **1**, 44
  - cell, high pressure, **3**, 570
    - infrared, **1**, 306
    - ultraviolet, **1**, 429-430
  - gas by charcoal, of, **7**, 66-67
  - indiarubber, **2**, 229-233
  - liquids, **2**, 200-209
  - light, of, **1**, 84-89, 242

## Absorption and emission—*cont.*

- gas by charcoal—*cont.*
- light, of—*cont.*
  - concentration, and, **9**, 360-362
  - resonance, **3**, 123
  - state of aggregation, **1**, 492-493; **2**, 1-6
  - temperature, **4**, 378
- atmosphere, by, **1**, 422-426
  - crystals, **1**, 298-304
  - organic compounds, **1**, 484-491
- theory, **1**, 350-351, 385-389, 492-499; **2**, 1-6; **7**, 70
- microwaves, **5**, 17-18
- $\beta$ -rays, **9**, 430-431
- sound, **3**, 123
- tantalum, **7**, 50-51
- water by bubbles, **8**, 89-99
- X-rays, **4**, 487
- reflection, **1**, 487-488
  - correction, **8**, 275-283
- spectra, theory, **7**, 370
- ultraviolet by atmosphere, **1**, 89
  - gases, of, **1**, 430-431
  - glass, of, **1**, 88-89
  - liquids, of, **1**, 430-431
  - sodium chloride, of, **1**, 429-430
  - solids, of, **1**, 430-431
- Henry's law, **7**, 473
- infrared and concentration, **1**, 349
  - atmosphere, of, **1**, 422-426, 531
    - boracic ether, **1**, 391
    - bromine, **1**, 390
    - carbon disulphide, **1**, 390
    - chlorine, **1**, 390
    - crystals, **1**, 297
    - ethylene, **1**, 382
    - gases, **1**, 305-308, 348-351, 390, 463-466
    - hydrogen chloride, **1**, 390

**Absorption and emission—*cont.***infrared and concentration—*cont.*atmosphere, of—*cont.*

liquids, 1, 466, 492–493

lampblack, 1, 390

oxygen, 1, 382

ozone, 1, 392

polluted air, 1, 424–425

solids, 2, 5

sulphur, 1, 390

vitreous humour, 1, 305

effect of state of aggregation, 1, 466

theory, 1, 463–466

Janssen's law, 5, 1–2

**Abundance of elements, 10, 272****Acceleration and radiation, 8, 229–230**

due to gravity, 8, 189

**Accelerator for protons, 9, 496–499**

multiple, 9, 498–499

**Accumulator, 6, 375****Acenaphthene, 8, 384****Acetaldehyde, 1, 56, 156**

azide, 7, 201–202

ethane flame, in, 6, 303

formula, 1, 272

infrared spectrum, 3, 215

rosaniline, reaction with, 1, 572

sulphuric acid, reaction with, 1, 56

viscosity, 5, 142–154

**Acetamide azide, 7, 201–202**

infrared transmission, 8, 287

phosphorescence, 4, 377

**Acetate buffers, 5, 498****Acetates, Kolbé electrolysis, 8, 344****Acetic acid, 1, 76, 155–156, 479**

anhydride, 1, 76–77; 3, 372

infrared transmission, 8, 257

viscosity, 5, 142–154

azide, 7, 201–202

biosynthesis, 3, 549

coal, from, 1, 399

diffusion through rubber, 7, 485

dissociation, 7, 198

ester diazide, 7, 201–202

formula, 1, 272, 541–542, 546–547, 574

infrared transmission, 8, 287

Kolbé electrolysis, 8, 344

maximum conductivity, 5, 491

phosphorescence, 4, 377

preparation, 1, 102, 142, 146, 270–271, 274

**Acetic acid—*cont.***

pressure and melting point, 7, 17–18

ultraviolet absorption, 1, 430–431

viscosity, 2, 212–213; 5, 142–154

water foam, 4, 26

mixtures, viscosity, 2, 212–213

**Acetisoeugenol, 6, 13****Acetoacetic ester, 3, 370**

diazide, 7, 201–202

infrared transmission, 8, 287

**Acetone azide, 7, 201–202**

coligative properties, 7, 14

formula, 1, 272

hydrazine production, in, 7, 196

infrared transmission, 8, 286

preparation, 2, 146; 3, 363

structure, 2, 199

viscosity, 2, 212–213

water mixtures, 2, 212–213

**Acetonitrile, hydrolysis, 1, 479**

infrared transmission, 8, 288

reduction, 1, 481

vapour, diffusion, 7, 471

**Acetophenone, infrared transmission, 8, 286**

phosphorescence, 4, 377–378

**Acetyl cellulose, 9, 259**

chloride, 1, 76

infrared transmission, 8, 287

**Acetylene, 1, 567–568**

action of hydrogen atoms, 10, 392

active nitrogen, and, 7, 309

coal, from, 1, 399

ethane explosion, 6, 313

flames, 3, 178

combustion, 6, 303–313

chlorine chemiluminescence, 9, 219

critical constants, 3, 315

decomposition, 9, 349–351, 491–494

detonation, 9, 491–494

deuterium-substituted, 10, 63–64

dibromide, 5, 141–154

explosion, 6, 302

flame, 5, 33

velocity, 9, 468

formula, 2, 198

formation in arc, 1, 143

heat of formation, 9, 493

hydrogen combustion, 6, 308

liquefaction, 3, 27

molecular structure, 1, 567; 7, 504

**Acetylene—*cont.***

- nitrogen mixtures, arc in, 2, 198
- oxygen compression, 8, 303
- flame temperature, 7, 237
- velocity, 4, 145–146
- radical, 4, 205–207
- reaction with nitrogen, 3, 82
- reduction, 1, 481
- refraction, 6, 162
- shock wave in, 9, 493
- spectrum, 3, 174–186
- synthesis, 1, 481
- test for, 2, 143; 3, 81
- thermal decomposition, 9, 349–351, 491–494

**Acheson graphite, 7, 31****Achromatic glasses, 5, 445**

- microscope, 1, 122–126
- objective, 4, 185

**Achromatism, 1, 122****Acicular crystals, 7, 331****Acid amides, 8, 287**

- anhydrides, 1, 74–77
  - infrared transmission, 8, 287
  - viscosity, 5, 142–154
- catalysis, 6, 102
  - of mutarotation, 7, 383
- chlorides, 1, 76
- dissociation, 6, 96; 7, 366
  - constants, 7, 198
- effect on muscle, 5, 422
- green, 3, 368
- hydrolysis of hydrocyanic acid, 1, 159

- salts, 1, 329

- yellow, 3, 368

**Acids, 1, 327–333**

- aliphatic, 1, 546–547
- dibasic, 5, 497–498
- displacement reactions, 6, 96
- double decomposition, 1, 20–21
- electrosynthesis, 8, 344–345
- infrared transmission, 8, 283, 287
- maximum conductivity, 5, 491
- neutralisation, 6, 96
- optically active, 6, 33–34
- organic, 1, 74–77
- oxygen, 1, 74–75
- phosphorescence, 4, 377
- refraction, 6, 161
- rosaniline, effect on, 1, 397

**Acids—*cont.***

- tantalum, effect on, 7, 49
- theory, 1, 74–77
- viscosity, 5, 35–54
- weak, 6, 96

**Acieration, 2, 47–48, 233–239****Acigite, 1, 303****Acoustic distillation, 9, 291**

- experiments, 1, 246–248
- intensity, 8, 363–369
- interference, 5, 476–482
- properties of crystals, 1, 295
- reflection, 4, 279–280
- refraction, 4, 279–280
- reversibility, 2, 413–419
- shadows, 6, 54–61
- waves, 9, 285–289

**Acoustics, 3, 1–7, 454–465; 9, 297–311**

- architectural, 8, 364
- concave surfaces, of, 6, 60–61
- horn, 8, 369

- Faraday's work, 4, 155

- ultrasonic, 9, 281–296

**Acrylic acids, 1, 574–576****Actinia equina, 10, 236****Actinide elements, 10, 254–256****Actinium,****A,**

- half-life, 6, 278; 8, 457
- lanthanum, and, 8, 120
- mesothorium II, and, 8, 122

**B, half-life, 6, 278; 8, 457****C,**

- disintegration, 9, 10–12
- half-life, 8, 457

**chemical properties, 8, 120****D,**

- half-life, 8, 457
- thallium, and, 8, 122

**discovery, 5, 512; 6, 40****emanation *see actinon*****half-life, 8, 457****isolation, 6, 282****isotopes, 8, 457****radioactivity, 5, 512–524****radium from, 7, 258****series, 6, 278****uranium ratio, 6, 280****X, half-life, 6, 278; 8, 457****Actinometer,****chlorine dioxide, 7, 82–83**

- Actinometer—cont.**  
 hydrogen-chlorine, 1, 457–458  
 photographic, 1, 457–458  
 uranium nitrate, 7, 82–83
- Actinometry, 1, 202–204, 319–326, 456–462**  
 electrochemical, 3, 8–10
- Actinon,**  
 half-life, 6, 278; 8, 457  
 inert gas, 7, 71  
 particle spectrum, 9, 413–414
- Action at a distance, 1, 59–64, 71, 143–149, 230, 233, 238; 2, 79, 372–382, 528–539**  
 capillary, 3, 325–349  
 chemical, 1, 236  
 current, 5, 422  
 detergent, 9, 64  
 law of mass, 7, 248  
 principle, 5, 565; 9, 206
- Activation energy, 10, 385–403**  
 surface, 7, 408
- Active nitrogen, 7, 306–311; 8, 475–487; 9, 222**  
 copper oxide, and, 7, 308  
 electronic structure, 8, 486–487  
 luminosity, 7, 306  
 production, 7, 306  
 reactions, 7, 309–311  
 spectrum, 7, 309
- Activity, demonstration of optical, 6, 31**
- Acuba virus, 10, 223**
- Adamantine, 2, 384; 4, 535**  
 carbon, 4, 535  
 silicon, 2, 384
- Aden, 7, 94**
- Adhesion, 10, 203–204, 211–214**
- Adiabatic expansion, 6, 383**  
 demonstration, 6, 383  
 helium, of, 6, 383  
 hydrogen, of, 6, 383
- Adsorption and catalysis, 8, 28–29**  
 charcoal, by, 6, 104–119, 210–231, 251–254, 393–404  
 kinetics, 6, 251–254  
 chemical, 2, 43–44, 229–233  
 diffusion, 1, 42–44  
 gas mixtures, of, 6, 397–399,  
 water by sodium chloride, 1, 424–425
- Adsorption and catalysis—cont.**  
 heats, 6, 108–111, 255  
 isotherm at low temperature, 6, 214–216  
 low temperature, at, 6, 104–119  
 pressure, 6, 105
- Adularia, 1, 299**
- Aeolian harp, 7, 437**
- Aerodynamics, 5, 294–298**
- Aeroplane, 5, 294–295**
- Aesculine, 3, 257**  
 fluorescence, 1, 489
- Aether, 3, 380–381; 4, 189–204; 5, 324–329; 6, 287–298; 8, 102–103, 212–235**  
 electrons, and, 5, 564–567  
 gravity, 6, 289–290, 295–296  
 inertia, 6, 294  
 mass, 6, 291  
 matter, 2, 528–539; 8, 212–235  
 existence of, 2, 7–12  
 lack of friction, 4, 196  
 motion of, 4, 189–204  
 rejection of, 8, 102–103  
 theory of, 1, 78; 3, 350–351; 5, 324–329  
 velocity, 4, 196; 8, 101, 181–197  
 viscosity, 5, 324  
 vortex theory, 4, 394
- Agar 9, 173–181**
- Agate, 7, 54**
- Agave, 5, 23**
- Ageing of magnet, 4, 542**
- Agglutinating power, 9, 295**
- Aggregation, 1, 78–83**  
 state of and light absorption, 1, 466, 492–493  
 resistance, 4, 426
- Ague, 3, 372**
- Aigrette, 4, 503**
- Air (see also atmosphere)**  
 adiabatic expansion, 6, 383  
 adsorption,  
 alumina, on, 6, 213–214  
 charcoal, 7, 66–67  
 electrons, of, 5, 47  
 alcohol diffusion, 7, 485–486  
 alcohol on liquid, 4, 234  
 applications of liquid, 5, 158–169  
 blast on arc, 3, 223  
 breathed in treadmill, 1, 378

*Air—cont.*

- carbon arc in, 3, 176
- city, 7, 461
- conduction of magnetism by, 1, 11–12
- conductivity, 6, 19–21; 10, 28–29
- constituents, 6, 435
- demonstration of magnetism, 4, 221
- density, 2, 154
  - of liquid, 4, 463
- dielectric breakdown, 3, 98–99
  - constant of liquid, 5, 462
- discovery of weight, 2, 285
- diffusion into carbon dioxide, 5, 374
  - bubbles, through, 8, 78–87
  - collodion, through, 8, 3–4
  - graphite, through, 2, 224–229
  - rubber, through, 7, 471–486
- drops of liquid, 7, 230–232
- dust-free, 8, 311–312
- early theories, 2, 285
- effect in water, 1, 131–133
  - of liquid on bacteria, 5, 470–471
    - on vitamins, 8, 375
- electroluminescence, 7, 67–70
- electrons per cc, 8, 59–60
  - molecule, 8, 59–60
- engine, 1, 235
- evaporation of liquid, 4, 221
- expansion, 4, 3
- filtering, 8, 311–312
- fractionating of liquid, 6, 383
- gap electroscope, 4, 335–336, 341
- ground temperature, and, 3, 275–280
- heat transmission of liquid, 5, 465
- helium in, 7, 455–465
- hydrogen in, 5, 470
- ionisation, 6, 42
- infrared absorption, 1, 306, 349
  - emission of, 1, 381
- introduction in candle flame, 1, 363
- jet, ball on, 5, 278
- Joule-Thompson effect, 4, 5
- krypton in, 5, 466–467
- latent heat, 4, 264
- light scattering by, 8, 311–317
- liquefaction, 4, 219, 457
  - demonstration of, 4, 232

*Air—cont.*

- liquefaction—*cont.*
  - in, jet, 4, 46
    - sealed flasks, 4, 461–462
- liquid, 4, 223–234, 457–478; 6, 210–231
  - absorption spectrum, 5, 3–4
  - calorimeter, 7, 232–234
  - effect on phosphorescence, 4, 375–378
    - photography, 4, 378–380
  - refractive index, 4, 259
  - separation of gases by, 5, 157–161
    - uses, 4, 258–272
- low-temperature adsorption, 6, 213–215
- magnetism of, 1, 9–12, 68
- mass spectrum, 7, 186–191
- measurement of density of liquid, 6, 1–2
- melting of solid, 4, 460–461
- microwave transparency of liquid, 5, 18
- moist, infrared absorption, 1, 349
  - reaction with phosphorous, 1, 22
- mountain, 7, 461
- neon in, 5, 466–467; 7, 455–465
- phosphorous glow, and, 9, 26
- solid, 4, 264, 460–461
  - hydrogen, in, 4, 460–461
  - magnetic field, in, 4, 460
  - removal of liquid oxygen, 4, 460
- solubility of gases in liquid, 5, 468
- sound from, 3, 152
- specific heat, 1, 253–254
- spheroidal state, 5, 157; 6, 217
- spinning ball, on, 7, 104
- thermometer, 2, 343; 5, 244–247
- ultraviolet fluorescence, 7, 206, 220–222
- upper, 6, 436
- viscosity, 5, 248; 6, 387–388
- water
  - diffusion, 7, 485–486
  - from, 2, 275
- X-ray absorption of liquid, 5, 160
- xenon in, 5, 466–467
- Airships, dynamics, 7, 436
  - helium in, 9, 316
- Alanine, 9, 455

- Albatross, 5, 294
- Albumen, 5, 269; 6, 39; 10, 429  
 coagulation, 6, 188-189  
 colloidal, 1, 39; 2, 216-217  
 denaturation, 10, 219-220  
 film, 10, 422  
 molecular weight, 10, 416  
 phosphorescence, 5, 464; 7, 81  
 refractive index, 6, 166
- Albuminated calico membrane, 2, 217
- Alcohol, 1, 161, 479  
 absorption by palladium, 2, 47  
 action of,  
   fluorine, 5, 96  
   heat, 1, 478  
 adsorption on charcoal, 6, 106  
 aliphatic, 1, 545-546; 2, 478-492  
   synthesis, 1, 271  
 azide, 7, 201-202  
 biological oxidation, 3, 549  
 boiling by infrared, 2, 4  
 carbon dioxide bath, 8, 272  
 catalytic decomposition, 1, 160  
 composition of, 1, 19  
 critical point, 2, 294-295; 5, 361  
 crystallisation, of, 2, 209  
 decomposition, 1, 160; 6, 304  
 dehydration, 2, 209  
 depression of freezing point, 6, 97  
 determination of in beer, 6, 166  
 deuterium exchange, 10, 61-67  
 dielectric properties, 5, 462  
 diffusion of salts in, 1, 393-396  
   through rubber, 7, 485-486  
 dispersion, 3, 245-246  
 effect on,  
   glass wetting, 3, 346-347  
   water viscosity, 7, 440  
 ethane flame, in, 6, 303  
 etherification, 1, 18-21, 76  
 fermentation, from, 1, 56  
 formula, 1, 156, 207; 2, 199, 483-486  
 glass, 4, 263  
 gravitational effects, 5, 305  
 infrared absorption, 1, 493; 8, 273, 280-281, 286, 289  
   spectrum, 3, 212-214  
 isomerism, 1, 55  
 liquid air, on, 4, 234  
 magnetism, 1, 68
- Alcohol—*cont*  
 molecular structure, 1, 403  
 osmosis, 7, 5  
 oxygen flame, 1, 89  
 reaction with alumina, 1, 162  
 refractive index, 3, 245  
 solutions, diffusion, 7, 485-486  
 spherical drops, 1, 51  
 splashes, 4, 291-301  
 surface viscosity, 4, 36  
 synthesis, 1, 274-275; 2, 141  
 tears, 3, 347  
 ultraviolet absorption, 1, 430-431  
 vapour, diffusion, 7, 471  
 viscosity, 2, 212-213; 5, 142-154  
 volatility, 2, 401  
 water diffusion, 7, 485-486  
   foam, 4, 26  
   mixtures, viscosity, 2, 212-213  
   phase diagram, 2, 523
- Alcoholic potash, 1, 575
- Alcoholates, 2, 209
- Alcohols, 1, 574  
 higher, 2, 484, 486  
 occurrence, 2, 484  
 oxidation, 2, 484-485  
 phosphorescence, 4, 377  
 properties, 2, 484, 486  
 refraction, 6, 161  
 relation to paraffins, 2, 482-486  
 secondary and tertiary, 2, 485-487  
 silicon, 7, 58-59  
 spectra, 7, 362  
 synthesis, 9, 352-356  
 viscosity, 5, 135-154  
 X-ray diffraction, 9, 40-47
- Aldebaran, 1, 433-434
- Aldehyde-ammonia phosphorescence, 4, 377  
 green, 2, 188-189
- Aldehydes, aliphatic, 2, 487-489  
 infrared transmission, 8, 286  
 preparation, 2, 484  
 viscosity, 5, 136-154
- Alderley Edge, 2, 125
- Algae, 10, 235
- Aliphatic acids, 4, 377  
 azides, 7, 201-202  
 alcohols, 1, 271  
 compounds, molecular structure, 9, 508-510

- Aliphatic Acids *cont*  
 compounds— *cont*  
   spectra, 7, 362  
   esters, 4, 377  
   hydrocarbons, 5, 141–154  
 Alizarin, 1, 275, 2, 191, 240–245,  
   3, 368  
   coal, from, 3, 365–366  
   discovery, 2, 245  
   dyeing, 9, 21–22  
   formula, 2, 244–245  
   occurrence, 2, 242  
   reduction, 2, 244  
   relation to purpurine, 2, 243  
   sesquioxide nature, 5, 530  
   spectrum 2, 242  
   structure, 3, 172  
   synthesis, 2, 244–245, 3, 162 163,  
     365, 9, 24  
   world production, 3 171–172  
 Alkali blue  
   6B, 3, 368  
   R, 3, 368  
   catalysis of mutarotation 7, 383  
   contraction of cotton, 1, 34–41  
   tantulum, effect on, 7, 49  
   liquid air in, 6, 211  
   metal chlorides, 5, 37  
     halogen chemiluminescence, 9,  
       220–221  
   salts,  
     colouring by radium, 6, 49  
     radioluminescence, 6 41  
 metals 1, 210  
   discovery, 6, 262 274  
   earth's crust, in, 7, 54  
   valency, 8, 117  
   Zeeman effect 6, 208  
   muscle, effect on, 5, 422  
 Alkaline-earths, 1, 284–289  
   iron oxide, 9, 331  
   radioluminescence, 6, 41  
 Alkalis, dissociation 7, 366  
 Alkyl halides, 2, 439–441  
   magnesium halides, 7, 203  
 Alkaloids, 1, 482  
   detection, 7, 368  
   fluorescence, 4, 377  
   natural, 3, 369  
   nitrogen containing, 7, 195  
   optical activity, 3, 516  
 Alkaloids—*cont*,  
   phosphorescence, 4, 371, 5, 464  
   physiological action, 2, 182  
   spectra, 7, 355–369  
   structure, 7, 366  
   sugar beet, from, 3, 31  
   synthesis, 1, 275, 2, 145  
 Allotropy, 1, 36–37, 55 58, 134  
   antimony sulphide, of, 1, 37  
   arsenic, of, 1, 56–58  
   boron, of, 1, 56–58  
   calcium carbonate, of, 1, 36  
   carbon, of, 1, 56 58, 7, 22 23  
   cuprous mercuric iodide, of, 7, 121  
   garnet, of, 1, 36  
   ice, of, 8, 294  
   iron sulphide, of, 1, 37  
   mercury iodide, of, 1, 37  
   mercury sulphide, of, 1, 37  
   metals, in, 5, 192  
   oxygen, of, 1, 24, 56 58  
   phosphorous, of, 1, 56 58, 134, 259,  
     470 473  
   pressure, and, 7, 23  
   selenium, of, 1, 56 58  
   silicon, of, 1, 56 58  
   specific heat, and, 5, 192  
   sugar, of, 1, 37  
   sulphur, of, 1, 36 37, 56–58, 134  
     135, 7, 228  
 Alloys, action on a photographic  
   plate, 5, 258  
   allotropy, 5, 192  
   aluminium, 3, 507–509  
   crystal structure, 9, 214–216  
   Faraday's work, 9, 97  
   hardness, 9, 2  
   heat of formation, 5, 71–72  
   Heusler, 8, 489–509  
   iron at low temperature, 6, 425–426  
   low-temperature resistance, 4, 231  
   magnetism, 10, 488  
   mean atomic heats, 5, 191 192  
   phase behaviour, 2, 525–526  
   resistance, 4, 525–527  
   superconductivity, 9, 424–425  
   theory, 10, 226  
 Allyl alcohol, 2, 194  
   infrared transmission, 8, 286  
   structure, 2, 199  
   viscosity, 5, 142–54



- Allyl azoimide, 7, 203  
 Allyl bromide, 5, 142-154  
 Allyl chloride, 5, 142-154  
 Allyl iodide, 5, 142-154  
     infrared transmission, 8, 285  
     light scattering, 2, 172-177  
 Allyl thiocarbamide, 7, 60  
 Almond oil, 3, 372  
 Aloes, 5, 23  
 Alpha particles (*see particles*)  
 Alternating current electrical supply,  
     4, 97  
     high frequency, 4, 167-182; 5, 501  
     magnet, 8, 489-501  
     sound from, 4, 168  
     superconductivity, 9, 429  
 Alternating magnetism, 8, 489-509  
 Alternators, effect of condenser, 4,  
     168  
     high frequency, 4, 167; 7, 267-278  
 Altitude, effect on photography, 2, 14  
     of sun and light scattering, 2, 17-18  
     ultraviolet rays at, 3, 436  
 Alum, 1, 536  
     cleavage, 4, 120  
     crystal form, 1, 303; 4, 114  
     structure, 8, 321  
     density, 6, 6  
     diffusion in water, 1, 394  
     emission of infrared, 1, 350-351  
     expansion, 6, 6  
     infrared absorption, 1, 350-351;  
         2, 5  
     specific heat, 6, 85-87  
     supersaturation, 3, 399-400  
     water eutectic, 2, 522  
     X-ray diffraction, 7, 353  
     zoned crystals, 4, 52  
 Alumina, 1, 162  
     absorption by, 213-214  
     alum crystallisation, effect on, 1,  
         303  
     artificial photosynthesis, in, 9, 195  
     colloidal, 1, 396; 2, 216-217; 10,  
         150  
     crystal structure, 8, 321-324, 330;  
         9, 81, 84, 87  
     furnaces, in, 7, 239  
     fused alkali, effect of, 7, 33  
     glass, in, 9, 157  
     hardness, 8, 330  
 Alumina—*cont.*  
     insulation in Dewar vessel, 5, 164  
     mordants, 3, 168, 170  
     phosphor, 3, 51-53  
     pressure effect, 7, 31  
     reaction with ammonium salts, 1,  
         127  
     thixotropy, 10, 150  
 Aluminium, 3, 496-509  
     absence from sun, 1, 359  
     absorption,  
         electrons, of, 5, 47  
          $\gamma$ -rays, 7, 505  
         X-rays, 8, 46-54  
     abundance, 10, 272  
     alkyls, 1, 535-538  
         dimerisation, 1, 538  
     alloys, 3, 507-509  
     amalgam, 2, 497  
     anticathode, 6, 112  
     atomic heat, 7, 401  
         radius, 8, 326  
         refraction, 2, 540  
         spectrum, 3, 72-78  
         temperature, and, 8, 104-106  
         volume, 7, 401  
         weight, 1, 500-508, 536; 2, 325,  
             546  
     bacteria, action on, 7, 86-92  
     barium, absorption spectrum, 3, 72  
     bronze, 3, 507-508  
         action on bacteria, 7, 86-92  
         hardness, 9, 2  
         resistance, 4, 525-527  
     calcium silicate, 1, 331  
     carbide, 10, 49  
     carbonate, 9, 195  
     cathode, 6, 243  
     chemical properties, 3, 506-507  
     chloride, 2, 217  
     copper couple, 2, 497  
     combustion, 3, 506  
     cost 1889, 3, 496  
     crystal structure, 8, 320  
     discovery, 2, 315-317  
     earth crust, in, 7, 54  
     eddy currents in, 3, 306-311  
     electrodes, 5, 99; 7, 403  
     electron diffraction, 9, 191, 208-210  
     emissivity, 8, 290  
     ethyl, 1, 535-538

Aluminium—*cont.*

- foil, 9, 2
- formation of X-rays by, 4, 504
- heat of alloying, 5, 72–77
- Heusler alloy, in, 8, 489
- hydroxide, 3, 501
- industrial production, 3, 496–508
- iodine catalysed reactions, 2, 499
- ionic radius, 9, 80, 86
- lead thermocouple, 4, 538
- low-temperature resistance, 4, 230
- magnesium alloy, 10, 251
- magnetic field, in, 8, 506
  - sun, 1, 433
- manganese silicate, 1, 331
- manufacture, 3, 496–509
- mellitate, 6, 231
- melting, 7, 419
  - point, 7, 237
- methyl, 1, 535–538
- nuclear fission, 9, 13 16
- occurrence, 1, 536; 9, 245; 10, 272
- oxide (*see alumina*)
- paramagnetism, 9, 88–89
- penetration by X-rays, 4, 502
- permanganate, 6, 100
- physical properties, 3, 505–506
- phosphate, 1, 536
- photographic plate, action on, 2, 257–258
- platinum couple, 2, 497
- polishing, 10, 251
- potassium silicate, 1, 536
- preparation, 3, 496
- production, 1, 88–89, 285; 3, 496
- proton liberation from, 9, 74–76
- rate of discharge, 6, 21
- reaction with chlorine, 3, 507
- removal of iron, 3, 503
- resistance, 4, 524–527
- rigidity, 8, 360
- scattering of  $\alpha$ -particles, 9, 9–10, 73–76
- silver alloy, 4, 525–527
- sodium chloride, 1, 536
  - manufacture, 3, 501–503
- sodium fluoride, 1, 536
- soldering, 3, 507
- specific heat, 2, 325; 7, 233–234
- steels, 3, 508–509
- sulphate,

Aluminium—*cont.*

- sulphate—*cont.*
    - density, 6, 6
    - expansion, 6, 6
  - titanium alloy, 4, 525–527
  - trace in explosion, 3, 445–450
  - transmission of radioactivity, 5, 508
  - trichloride, 1, 536
  - triethyl, 1, 538
  - triethiooxide, 2, 499
  - trimethyl, 1, 538
  - uses, 3, 507
  - ultraviolet spectrum, 3, 259, 266
  - X-ray absorption, 4, 488; 5, 160
    - target, 8, 50
  - Young's modulus, 8, 354–355
- Aluminous acid, 1, 333
- Amalgam,
  - ammonium, 2, 246
  - potassium, 1, 271
- Amblygonite, 5, 22
- Americium, discovery, 10, 254 255
- Amethyst, 7, 54
  - colour, 4, 235
  - effect of heat, 9, 165
  - in quartz, 4, 51
  - optical properties, 1, 57
  - twinning, 7, 340
- Amides,
  - infrared transmission, 8, 283, 287
  - synthesis, 1, 480
- Amidol, 4, 480
- Amine radical, 2, 247
- Amines, infrared transmission, 8, 287–288
- Amino acids, 8, 26; 9, 455–456; 10, 415–416
  - crystal structure, 9, 461
  - proteins, in, 10, 218–219
- Amino group, auxochromic character, 5, 529
- Aminobenzoic acids, 3, 163
- Aminoethylenic, 7, 204
- Aminophenylacetic acid, 3, 165
- Aminophthalic anhydride, 9, 219
- Aminoxindol, 3, 165
- Ammeter, 6, 376
- Ammonia, 1, 330; 2, 246–253; 7, 195
  - absorption by water, 2, 237
  - action of hydrogen atoms, 10, 394–397

**Ammonia—*cont.***

- adsorption by charcoal, 6, 105, 395
- alkaline character, 1, 207
- biosynthesis, in, 1, 272
- boiling point, 6, 75, 429
- carbon arc in, 3, 177
- catalytic combustion, 1, 160
- chemistry, 1, 205–213; 3, 28
- chlorine reaction, 9, 219
- chromyl chloride reaction, 9, 219
- coal, from, 1, 400; 3, 29; 9, 340
- critical constants, 3, 315
- diamagnetism, 4, 220
- diffusion,
  - through rubber, 7, 471
  - water, 2, 42–44
- discovery, 2, 246
- double decomposition, from, 1, 21
- electric discharge in, 1, 473
- evaporation temperature, 6, 75, 429
- formula, 1, 154–155, 446–450, 455
- hydrogen,
  - chloride reaction, 7, 100
  - exchange, 10, 19
- industrial synthesis, 8, 294
- infrared,
  - spectrum, 3, 213; 9, 225–226
  - transmission, 8, 284
- light scattering, 9, 274
- liquefaction, 9, 98
- magnetism, 1, 68
- molecular structure, 1, 402, 555–556; 9, 503
- moments of inertia, 9, 227
- nitrogen from, 4, 397–398
- phosphorous glow, 9, 27
- production, 1, 127
- rate of dissolution, 2, 398–399
- ratio of specific heats, 5, 337
- reaction with,
  - alumina, 1, 162
  - boron trichloride, 2, 197
  - chloroform, 2, 197
  - nitrous acid, 7, 197
  - phosgene, 7, 383
  - silicon tetrachloride, 2, 391
- refrigeration, 4, 218
- solid, 3, 25
- solidification, 9, 98
- solubility in water, 2, 246

**Ammonia—*cont.***

- solution of silver chloride, 1, 21
- sound from, 3, 153
- specific heat of solid, 6, 85–87
- structure, 3, 542
- temperature, critical, 6, 75, 429
- vibrations, 9, 227–228
- viscosity, 2, 219–221

**Ammoniacal copper sulphate, 1, 220****Ammoniacal cupric chloride, 2, 143****Ammoniacal cuprous chloride, 3, 81****Ammoniacal nickel sulphate, 1, 225****Ammonites, 4, 186; 10, 157****Ammonium,**

- alum, 1, 127–128
- amalgam, 2, 246
- azide, 7, 196–197
- bromide-water eutectic, 2, 522
  - supersaturation, 3, 400
- chloride, 1, 24; 2, 246
  - action of heat, 5, 86
  - crystallisation, 7, 326
  - density, 6, 6
  - deuteron bombardment, 10, 24
  - dissociation, 7, 100
  - electrolysis, 2, 246
  - expansion, 6, 6
  - history of use, 3, 28–29
  - specific heat, 6, 85–87
  - supersaturation, 3, 400
  - vaporisation, 6, 91
  - volatility, 2, 400
- water eutectic, 2, 522
- water phase diagram, 2, 523
- chromate, 7, 327–328
- cyanate, 1, 270, 476
- ferrous sulphate, 7, 351
- fluoride, 5, 86
- formate, 1, 452
- hydroxide, 1, 211
- ion,
  - infrared spectrum, 9, 229
  - radius, 9, 86
- iodide, 1, 207
  - infrared transmission, 8, 288
  - optically active derivatives, 6, 33
  - water eutectic, 2, 522
- mellate, 1, 299–301
- metaphosphate, 2, 502
- metavandate, 2, 502
- nickel sulphate, 4, 509

**Ammonia—*cont.***

- nitrate, 1, 211
    - decomposition, 1, 50
    - water eutectic, 2, 522
    - water phase diagram, 2, 523
  - nitrite,
    - nitrogen from, 4, 398
    - rate of decomposition, 2, 134
  - oleate, 7, 331–332
    - liquid crystals, 9, 65
    - solution, rigidity, 9, 173–181
  - perchlorate, 7, 327–328
  - permanganate, 6, 100
  - platinum chloride, 4, 261; 5, 463; 6, 428
  - platinocyanide, 4, 377–378
  - radical, 1, 210–211; 2, 46
  - salts, reaction with alumina, 1, 127
  - selanate, 7, 327–328
  - soaps, 8, 18–19
  - sodium hydrogen arsenate, 3, 400
  - sulphate, 1, 207, 211
    - action of heat, 5, 86
    - crystals, 7, 327–328
    - deuteron bombardment, 10, 24
    - optical properties, 1, 301
    - water from, 5, 86
    - water eutectic, 2, 522
    - water phase diagram, 2, 523
  - sulphide, 3, 164
  - tartrate, 1, 7–8
  - vanadate, 2, 124–126
  - zinc sulphate, 7, 352
- Amoeba**, 8, 31
- Amorphous carbon**, 6, 406–417; 8, 370
- Amorphous phosphorous**, 1, 34–41
- Ampère's theory of magnetism**, 3, 281–282
- Amphibians**, 10, 341
- Amyl acetate**, 1, 274; 6, 12; 7, 490
  - formula, 1, 547–548
  - infrared transmission, 8, 287
- Amyl alcohol**, 1, 275, 479, 546; 2, 389, 484, 486–487
  - infrared transmission, 8, 286
  - glass, 4, 263
  - silicon-substituted, 2, 389
  - synthesis, 1, 271
- Amyl butyrate**, 8, 30
- Amyl ethyl oxalic acid**, 1, 521
- Amyl mercury**, 1, 518–522

**Amyl mercury—*cont.***

- chloride, 1, 518–522
  - iodide, 1, 518–522
- Amyl nitrite**, infrared transmission, 8, 288
  - light scattering, 2, 151–156, 172
- Amyl oxalate**, diamyl, 1, 521
- Amyl valerate**, 1, 274
- Amyl zinc**, 1, 139, 518–520
  - synthesis, 2, 440, 498
- Amylamine**, 8, 287
- Amylene**,
  - infrared absorption, 1, 493; 8, 285
  - nitrosate, 7, 202
  - production of acetylene from, 2, 143–144
  - spectrum, 3, 213–214
  - synthesis, 1, 271
- Analysis at low temperature**, 5, 468
  - carbon monosulphide, of, 7, 151–2
  - carbonisation products, of, 9, 326–331
    - charcoal, of, 6, 406
    - chemical, 2, 140–149; 6, 101
    - coal, of, 1, 404–405
    - crystallo-chemical, 7, 325
    - goniometric, 7, 350
    - harmonic, 6, 372
    - mass-spectrum, 7, 184–194
    - spectroscopic, 3, 440–450
    - sugar, of, 3, 527
- Analyser**, 2, 271, 357–361
  - model, 3, 519–522
- Ananas sativus**, 5, 23
- Anatase**, 7, 336
- Andalusite**,
  - dichroism, 4, 509
  - microwave bir-fringence, 5, 22
- Andes**, 5, 297
- Andrews**, CO<sub>2</sub> data, 2, 294–301; 5, 362
- Anemones**, sea, 10, 236
- Anemomia silicata**, 10, 236
- Anethol**, 6, 12
- Angite**, 4, 53
- Angle**,
  - Brewster's, 2, 170
  - contact, of, 3, 326, 332–349
  - critical, 1, 122
  - interfacial, 7, 120–134
  - object lens aperture, of, 1, 122–123

- Angles,**  
   crystal, 7, 333  
   five fundamental, 7, 331  
**Angular momentum,** 6, 368–369  
   quantisation, 8, 227  
**Anhydrides acid,** 1, 74–77  
   viscosity, 5, 142–154  
**Aniline,** 3, 370  
   black, 2, 506–509; 3, 170  
   blue, 1, 548  
   catalysis of mutarotation, 7, 383  
   chemical properties, 1, 405–408  
   chloride, 1, 572  
   coal, from, 1, 400  
     tar, from, 2, 184  
   discovery, 1, 569  
   dyes, 1, 569–573; 2, 506–509; 5, 395  
   formula, 1, 543–544; 2, 186  
   green, 1, 572  
   indigo, from, 3, 163  
   industrial production, 1, 569–570;  
     3, 364  
   infrared transmission, 8, 287  
   mauve, 1, 570  
   molecular structure, 1, 404  
   oxidation, 1, 570  
     acid dichromate, by, 1, 407  
     mercuric chloride, by, 1, 408  
   pink, 2, 190  
   production, 1, 569–570; 2, 364  
   purple, 1, 407–408  
   reaction with,  
     calcium chloride, 1, 407  
     carbon tetrachloride, 1, 408  
     nitrous acid, 7, 199  
     rosaniline, 1, 572  
     stannic chloride, 1, 408  
   red, 1, 548  
   synthesis, 1, 274, 407; 2, 145  
   test for, 1, 407, 507  
   violet, 1, 548  
   volatility, 2, 400  
**Animal matter,**  
   luminescence of decaying, 4, 375  
   thermodynamics, 6, 361  
**Animals and vitamins,** 8, 376  
   carotenoids in, 10, 235  
   emission of heat, 1, 377  
   fatty pigments, 10, 227–243  
   heavy water, effect of, 10, 20  
   in vacuo, 9, 233  
**Animals and vitamins—cont.**  
   mechanical work from, 1, 377–378  
   membrane, 2, 217  
   phosphorous in, 9, 26  
   pigments, 4, 235–240; 10, 227–243  
   silicon in, 7, 60–63  
**Anion,** 2, 73  
**Anis,** 7, 202  
   aldehyde, 6, 12–13  
**Anisotropic conductivity,** 5, 24–25  
   crystals, 7, 120  
   liquids, 9, 65–72  
   materials, elasticity, 8, 349  
   molecules, 9, 274–275  
   soap solutions, 9, 65–72  
   susceptibility, 10, 146–147, 172–177  
**Annealing furnaces,** 7, 419  
   glass, of, 7, 385  
   steel, of, 5, 447  
**Annihilation of force,** 1, 230–240  
**Annual variation in sun's intensity,**  
   2, 13–21  
**Anode,** 2, 73  
**Anorthic elements,** 7, 128  
**Anorthite,** 1, 331  
**Anthocyanidin,** 9, 115–121  
   chlorides, 9, 115–121  
**Anthocyanins,** 10, 227  
   analysis, 9, 114  
   chlorides, 9, 115–121  
   ferrichlorides, 9, 120  
   pigments, 9, 114–121  
   synthesis, 9, 120  
**Anthoxanthum odoratum,** 2, 146–147  
**Anthracene,** 6, 411–413  
   alizarin, from, 2, 191, 244–245; 3,  
     162–163  
   C-C distance, 9, 464  
   coal, 2, 399; 3, 365–366  
     tar, 2, 242; 9, 100  
     1 ton, 3, 365–366  
   colour, 6, 415  
   compounds, 2, 245  
   crystal structure, 8, 382–384  
   discovery, 2, 245; 9, 100  
   dyes, 3, 368  
   flakiness, 9, 42–43  
   magnetic susceptibility, 10, 146  
   molecular structure, 9, 509  
   oxidation, 2, 191  
   price, 3, 364–365

**Anthracene—cont.**

- reaction with liquid fluorine, 6, 425
- refractive index, 2, 544–545
- synthesis, 2, 244
- uses, 2, 241

**Anthraquinone, 2, 191****Anthrapurpurin, 3, 172, 368****Anthraquinone, 2, 244**

- production, 9, 103
- structure, 3, 172
- synthesis, 2, 244–245

**Anticathode, 4, 504**

- carbon, 5, 106–107

- pin-hole photography of, 5, 120–122

**Antimonic acid, 1, 206, 333****Antimonious acid, 1, 296, 333****Antimony,**

- absence from sun, 1, 359
- action of fluorine, 5, 95
  - on bacteria, 7, 86–92
  - photographic plate, 2, 257
- allotropy, 5, 192
- alloy, 9, 424–425
- atomic heat, 7, 401
- radius, 8, 326
- refraction, 2, 138, 540
- volume, 7, 401
- weight, 1, 500–508
- bismuth thermocouple, 5, 66
- breaking stress, 4, 269
  - and temperature, 5, 462–464
- chemistry, 1, 206–213
- diamagnetism, 1, 191; 9, 138
- discovery, 2, 315–316
- ethyl, 1, 139
- fluoride, 5, 89
- fluorine, reaction with, 5, 95
- lead thermocouple, 4, 538
- liquid fluorine, reaction with, 6, 425
- magnetism, 1, 191; 9, 138
- mass spectrum, 8, 339
- oxidation, 1, 23
- oxides, 2, 131
  - crystal structure, 8, 381–382
- production, 1, 285
- specific heat, 2, 325
- sulphide, allotropy, 1, 37
- suspension in ether, 3, 479
- surface tension of liquid, 4, 118
- thermopile, in, 3, 270–271

**Antimony—cont.**

- trace in explosion, 3, 446–450
- tree, 2, 338
- trichloride, 10, 238
- vibrations from, 1, 109
- Antinodal disc, 9, 309
- Antinodes, sound, 3, 456–458
- Antiperiodic, 3, 369
- Antiphlogiston, 2, 282–291
- Antipyrène,
  - constitution, 3, 370
  - discovery, 3, 370
  - production, 6, 273
  - synthesis, 3, 370–371
- Antipyretic medicines, 3, 369–372
- Antiscorbutic, 8, 374
- Antitoxins, 10, 414
- Antozone, 1, 282–283
- Antropogon, 6, 10
- Apatite, 1, 309–310; 2, 126–127; 5, 22, 84
  - chlorine analogue, 5, 84
  - fluorine in, 5, 84
  - microwave birefringence, 5, 22
  - phosphorescence, 1, 309–310
- Aperture and resolution, 4, 66–67
- angle of object lens, 1, 122–123
- diffusion through, 5, 379–390
- numerical, 6, 128–130
- Apigenin, 9, 116
- Apophyllite, 1, 303
- Apparatus for high pressure, 7, 29–32
  - hydrogen jet, 4, 476
  - induction, 1, 177–179
  - liquefaction, 4, 458, 469, 471
  - liquid hydrogen, 5, 463
  - polarisation, 5, 20
- Apple flavour, 1, 274
- Applications of interference, 4, 241–247
  - photography, 4, 58–71
  - polarised light, 7, 371–384
  - tantalum, 7, 46–53
- Aps coil, 4, 489
- Approach to absolute zero, 4, 223; 5, 459; 10, 71–98
- Aqua regia, 2, 268
- Arachinda, 4, 240
- Arago effect, 3, 304
- Aragonite, 9, 83, 87
  - allotropy, 1, 36

**Arbor,**

Dianae, 2, 335-337

Saturni, 2, 335

**Arborescent crystallisation**, 7, 327**Arc**, 7, 46 (*see also* electric discharge)

A.C., 4, 168

cadmium-magnesium, 7, 82

carbon, 8, 240

in different gases, 3, 176-179

for spectroscopy, 3, 72-73

copper, 7, 83

disc, 6, 181-182

electrode shape, effect of, 3, 99-101, 106

length, 3, 98-99

light, 7, 46

for film making, 10, 133-134

magnetic field, in, 3, 220-226; 6, 181-182

mercury, 7, 372-377

musical, 5, 500-507

oscillators, 7, 285-293

projection, for, 4, 184

resistance, 5, 504

temperature, 3, 88-90; 5, 236; 7, 237

use of rotating mirror, 3, 108-110

variations in luminosity, 3, 97

**Archaean age**, 8, 112**Architectural acoustics**, 8, 364**Arcturus**, 8, 183**Argon**, 4, 447-456

adsorption by charcoal, 6, 397-404

atomic radius, 8, 329

spectrum, 4, 407-408

structure, 8, 226

weight, 5, 160, 465, 467; 7, 71; 8, 340

atmosphere, in, 4, 408

Bath gas, in, 4, 455; 5, 159

benzene, action on, 4, 406

boiling point, 5, 467; 7, 71

Buxton springs, in, 4, 455

carbon monoxide flame, effect on, 8, 475-487

Crooke's radiometer, in, 4, 407

density, 4, 407-408, 447-449; 5, 467

diffusion, 4, 409-410

through rubber, 7, 475-486

discovery, 4, 400; 5, 466

electric discharge in 9, 122-130

**Argon—*cont.***

electronic structure, 8, 327

element, 4, 410

heat of adsorption on charcoal, 6, 109-110

helium in, 4, 455

helium ratio, 7, 462

inertness, 4, 405-406

ion, 7, 186-187

isolation, 4, 447-449; 5, 466

isotopes, 8, 336-340

light scattering, 9, 274

liquefaction, 5, 467

liquid, 4, 461

krypton ratio, 7, 462

mass-charge ratio, 7, 295

mass spectrum, 8, 336-338

melting point, 7, 141

Na, 4, 410-411

 $\alpha$ -particles in, 8, 536

positive rays, 6, 243

pressure and melting point, 7, 141

ratio of specific heats, 4, 108; 5, 335

recoil, 9, 415

refractive index, 4, 449-453

solid, 4, 461; 5, 160

solubility in water, 4, 406

titanium, action on, 4, 406

translation energy, 4, 408

viscosity, 4, 454-455

X-ray absorption, 5, 160

xenon ratio, 7, 462

zero valency, 5, 560

**Aristarchus**, 7, 216-217Aromatic compounds,  
refractive index, 2, 544-545

structure, 9, 508

Aromatic hydrocarbons,  
infrared transmission, 8, 285

viscosity, 5, 142-154

**Aromatophoric groups**, 6, 11**Airhenite**, 3, 410**Arrhenius equation**, 10, 385-403

Arsenate ion, structure, 9, 503

Arsenates, study by Graham, 2, 207

**Arsenic acid**, 1, 333

allotropy, 1, 56-58

alloys, 9, 424-425

atomic heat, 7, 401

radius, 8, 326

refraction, 2, 138, 540

**Arsenic acid—*cont.***atomic heat—*cont.*

volume, 7, 401

weight, 1, 500–509, 535; 2, 325, 540; 8, 340

chemistry, 1, 206–213

chloride, 1, 68

discovery, 2, 315–316

ethyl, 1, 139

fluorine, action of, 5, 95

on bacteria, 7, 86–92

fluorine, reaction with, 5, 95

isotope, 8, 339–340

liquid fluorine, reaction with, 6, 425

mass spectrum, 8, 339–340

oxidation, 1, 23

oxide, occurrence, 2, 500

oxides, 2, 131

oxygen flame, 2, 152

pentafluoride, 5, 93

specific heat, 2, 325

sulphide, 9, 81

trace in explosions, 3, 446–450

trifluoride, 5, 93

**Arsenious acid, 1, 206, 333, 477**

action on bacteria, 7, 86–92

crystalloluminescence, 4, 507

**Arsine, 1, 206, 209, 330**

formula, 1, 455

infrared spectrum, 9, 266

oxygen explosion, 3, 447

triethyl, 1, 536

vibrations, 9, 227–228

**Arsonates, 10, 350****Artificial disintegration of elements, 9, 13–16**

isotopes, 10, 109–111, 254

musk, 6, 13; 7, 195

perfumes, 6, 10–14

photosynthesis, 9, 195–200

retina, 5, 434

silk, 9, 246

ultramarine, 9, 164

violet, 6, 11–14

**Artillery, 2, 275****Artists and colourblindness, 3, 340****Aryane, 9, 121****Asbestos,**

adsorption by, 6, 105

liner, 8, 299–304

**Asparagine, 1, 7–8; 4, 373; 9, 250–251****Asparagine—*cont.***

optical rotation, 1, 7–8

phosphorescence, 4, 373

wool, in, 9, 250

X-ray diffraction, 9, 250–251

**Aspartic acid, 1, 7–8**

Asperula odorata, 2, 146–147

Ash from coal, 9, 336–340

Assay Gray-King, 9, 326–331

Astacene, 10, 236

Aster, 9, 115

Asterism, 4, 187

Asteroids, 8, 226

Astigmatism of X-rays, 5, 119–120

Young's work, 5, 278

Aston mass spectrometer, 8, 332–342

Astronomical clock, 4, 359

determination of light velocity, 2, 435

masses, 4, 350–351

Astronomy, use of polarised light, 2, 393

Asymmetric carbon, 6, 31

Asymmetric silicon, 7, 59

Atlantic telegraphy, 6, 366–367

Atmosphere (*see also* air)

absorption of,

infrared, 1, 307, 349, 531

solar radiation by, 3, 275–278

ultraviolet, 1, 89

argon in, 4, 408

constitution, 1, 422

cosmic rays in, 10, 31

crystals in, 7, 327

dust-free, 8, 136

dust particles in, 2, 156–157

helium in, 4, 455–456

hydrogen in, 5, 470

inert gases in, 7, 141

infrared absorption, 1, 307, 349, 531

ionic, 9, 410

magnetism, 1, 2–3, 9–12

nitrate production from, 6, 181–182

opalescence, 2, 13–21

scattering by, 2, 13–21, 56–77

solar, 3, 261–262

water in, 1, 422, 494; 3, 275–280

**Atmospheric burner, Teclu, 9, 172**

electricity, 1, 334–337; 6, 372–373

gases, 6, 435–436

moisture, 1, 422, 494; 3, 275–280



**Atmospheric burner, Teclu—*cont.***

pressure and height, 3, 105–106  
spectrum, 4, 219–220

**Atomic,**

absorption spectroscopy, 3, 63–79  
collisions, 8, 244–252  
    with neutrons, 9, 416–418, 496  
contact, 6, 288  
heats, 1, 535; 2, 324–325; 5, 391–401; 8, 103  
    alloys, of, 5, 191–192  
    electrons, effect of, 8, 104  
    low temperature, at, 8, 104–106  
hydrogen, 9, 221; 10, 390–398  
mass, 5, 404  
    of hydrogen, 7, 178  
motion in crystals, 7, 454  
nucleus, 7, 502; 9, 6–16, 73–76  
number, 7, 452; 8, 58  
    Bohr radius, and, 8, 227  
    electrons, and, 8, 132  
    nuclear charge, and, 8, 133  
    radius, and, 8, 326  
    weight, and, 8, 132  
    X-ray diffraction, and, 8, 132  
particles, 8, 244–252  
    photography, 7, 312–324  
radius, 8, 325–326, 381  
    and number, 8, 326  
radiation, 4, 22–23; 7, 501–511  
recoil, 7, 503; 8, 246, 536  
refraction, 2, 136–139, 540–545  
    iron, of, 4, 212  
    nickel, of, 4, 211–212  
size, 3, 227–256; 5, 556; 10, 2–3  
spectra, 1, 354–359, 431–434; 2, 318–327; 3, 63–79, 121–135, 443; 8, 32–46  
    kinetic theory, and, 8, 238  
    coincidences, and, 3, 200–203  
    Doppler effect, and, 8, 238  
    electric field, in, 8, 239  
    line shapes, 8, 236–243  
    metals, of, 1, 431–434  
    Stark effect, 8, 239  
    structure, and, 8, 226–235  
spectrum of radium, 6, 52  
structure, 4, 23; 5, 48, 409; 6, 135–149; 7, 502; 8, 56–65, 113–135, 221–226

**Atomic—*cont.*****structure—*cont.***

$\alpha$ -particles, and, 8, 520–536  
spectra, and, 8, 226–235  
X-rays, and, 7, 451  
theory, 1, 19; 2, 177–183; 3, 122  
    Bohr's, 8, 42–45  
    Dalton's, 6, 24  
    history, 5, 555–556  
    isotopes, and, 8, 332  
    magnetism, of, 1, 140–142  
valency, 5, 560–562  
vibration frequency, 7, 509–511  
volume, 5, 213; 7, 336–337; 8, 325  
    at 15°, 7, 401  
    measurements, 4, 4  
    theory, 8, 131  
vortex, 6, 371  
weight, 1, 500–508; 2, 340–341; 8, 332–342  
    anomalies, 7, 452  
    argon, of, 5, 160  
    defects, 8, 219  
    determination, 8, 128–130  
    inert gases, of, 5, 467  
    isotopes, and, 8, 114  
    number, and, 8, 132  
    oxygen, of, 1, 445  
    X-rays, and, 4, 487; 5, 465; 7, 452–453

    effect on, 5, 112

**Atomicities, 1, 500–508****Atoms and aether, 6, 288**

asymmetric, 6, 31  
Boscovitch, 5, 331  
electronegativity, 8, 117  
electronic structure, 8, 327  
exploding, 7, 501–511  
fields in, 7, 502  
magnetic field, in, 9, 90–91  
 $\alpha$ -particle bombardment, 8, 131  
repulsive forces, 9, 79  
transmutation, 9, 495–499; 10, 22–27  
    of heavy, 10, 252–257  
unstable, 6, 275–286

**Atropine, 7, 366****Attar of roses, 6, 10–13****Attracted disc electrometer, 4, 98****Attraction capillary, 3, 227–256, 325–349**

Attraction capillary—*cont.*  
 chemical, 1, 18, 236–237, 373–380  
 convex surface by jet, of, 7, 438  
 gravitational, 4, 350–374  
 Attractive forces, 2, 158  
 between metals, 5, 68–71  
 review, 3, 325  
 Audible frequencies, 7, 266  
 Auramine, 3, 368  
 Auric bromide, 1, 129  
 Auric chloride, 2, 337–338  
 Aurin, 3, 365–368  
 from coal, 3, 365–366  
 Aurora Borealis, 1, 281; 3, 105–106;  
 4, 172  
 height, 3, 105–106  
 theory, 5, 414  
 Aurorae, 1, 281, 435–441; 3, 105–106;  
 4, 172; 5, 414–481  
 spectra, 5, 469  
 Auxochromic groups, 5, 529  
 Available energy, 6, 348–360  
 Avogadro's law, 6, 91; 7, 171–172  
 Avogadro's number, 5, 404; 7, 164–  
 183  
 measurement, 7, 164–183  
 Axial plane dispersion, crossed, 5, 548  
 lengths, relative, 7, 350  
 Axis,  
 crystal, 1, 294–304; 7, 334  
 earth, of, 1, 119–120  
 elasticity, 1, 294–304  
 polarisation, 1, 299  
 rotation, 1, 115–121  
 electric, 9, 283  
 morphological, 1, 294–304; 5, 541–  
 550  
 optic, 1, 5–6, 298–304; 9, 283  
 Axolote, 10, 341  
 Azides, 7, 197–204; 8, 288  
 aliphatic, 7, 201–202  
 decomposition, 7, 202  
 explosions, 7, 201  
 heavy metal, 7, 197–198  
 infrared transmission, 8, 288  
 light, action of, 7, 204  
 organic, 7, 198–204  
 polypeptide synthesis, in, 7, 200  
 Azo-dyes, 2, 190–192; 3, 367; 7, 195,  
 200; 9, 22  
 and cotton, 9, 22

Azo-dyes—*cont.*  
 fluorescence, 2, 191  
 synthesis, 7, 200  
 Azo-scarlets, 3, 365  
 Azocamphor, 7, 201  
 Azodinaphthyldiamine, 2, 190–192  
 Azophenylamine, 1, 570  
 Azophenyldinaphthyldiamine, 2, 191  
 Azotrinaphthylaminodiamine, 2, 191  
 Azoxyanisole, 7, 331  
 Azurate, 1, 332

## B

Babcock method, 5, 452  
 Babinet's compensator, 3, 12–13  
 Bacillus prodigiosus, 7, 92  
 Background radiation, 8, 311–312  
 Bacteria,  
 carotenoids in, 10, 236  
 chemicals, action of, 7, 86–92  
 chemiluminescence, 9, 218  
 low temperature, effect of, 5, 470–  
 471; 6, 437; 7, 80, 84  
 phosphorescence, 7, 83 92  
 rhodovibrio-, 10, 236  
 space, in, 5, 471  
 ultrasonics, effect of, 9, 295  
 ultraviolet light, 7, 84–92  
 Bacteriophage, 9, 295  
 Bacterium coli communis, 7, 92  
 Bacterium subtilis, 7, 92  
 Bain's telegraph, 4, 437  
 Balance,  
 Boy's, 4, 355–367  
 Coulomb's, 1, 185; 4, 352  
 common, 5, 301–303  
 magnetic, 1, 2, 64–73; 2, 96–103  
 measurement of gravity, 4, 354  
 torsion, 1, 64–73, 185; 4, 352, 355–  
 367; 10, 101–103  
 use of hydrogen, 4, 370  
 transpiration, 5, 251  
 Ball,  
 billiard, 8, 346  
 golf, 7, 104–119  
 jet, on, 5, 278; 7, 437  
 motion in water, 2, 515–517  
 Ballistic galvanometer, 5, 9

- Ballistics of rifled projectiles, 1, 117-118
- Balloons,  
atmospheric electricity measurements, in, 1, 343  
helium in, 9, 316
- Balmer series, 8, 224, 239, 333-346, 371-372  
deuterium, 10, 17-18  
line breadths, 8, 239
- Balsam, 3, 166
- Bamboo, 7, 61-63
- Bananas, 4, 237
- Band intensity and concentration, 5, 1-4
- Band spectra, 3, 124  
disappearance under pressure, 3, 196  
helium, of, 8, 372-373  
stars, of, 3, 131
- Bands,  
coloured and fluid motion, 4, 248-251  
glow discharge, in, 1, 316-318  
Lloyd's, 5, 450  
rotation, 9, 226-227  
Savart's, 3, 14-15, 529; 8, 313-314  
Swann, 5, 34-35  
vibration, 9, 226
- Bar,  
bending of viscous, 6, 71-73  
magnet, 1, 61-62, 65  
standard, 4, 363
- Barberry, 7, 364
- Barge, inertia, 8, 216
- Barium, 1, 284-289  
abundance, 10, 272  
acetate, 6, 94  
aluminium absorption spectrum, 3, 72  
atomic  
heat, 7, 401  
radius, 8, 326  
refraction, 2, 540  
spectrum, 1, 354-355; 3, 72-79, 266  
volume, 7, 401  
weight, 1, 500-509; 2, 540  
azide, 7, 198  
carbonate, 1, 128  
insulation, 5, 164  
chloride,  
Barium—*cont.*  
chloride—*cont.*  
diffusion into sodium sulphate, 5, 386  
solution, conductivity, 6, 94  
water eutectic, 2, 522  
colour test, 1, 354-355  
discovery, 2, 316-317  
ferrocyanide, 1, 162  
glass, in, 5, 445  
ionic radius, 9, 86  
nitrate, 2, 522  
oxide, 6, 167; 7, 36-37  
peroxide, 1, 282  
kinetics of iodide oxidation, 2, 134-135  
oxygen preparation, in, 1, 94  
reaction with carbon monosulphide, 7, 152  
platinocyanides, 4, 483-486, 509-510  
radioactive, 5, 512-524  
radium, and, 6, 52-53  
sealing wax, in, 7, 36  
spectrum, 1, 354-355; 3, 72-78, 226  
sulphate, 1, 128  
crystal structure, 7, 337  
isomorphism, 7, 337  
precipitate, 9, 70  
rate of precipitation, 2, 133  
sulphide, 1, 310-312  
ultraviolet spectrum, 3, 266
- Bark, horse chestnut, 1, 88
- Barkhausen effect, 10, 460
- Barley, 2, 402
- Barometer, 5, 451  
invention, 2, 284-285
- Baryta, 1, 127-128  
mixed hydrate with lime, 1, 28  
oxygen preparation, in, 1, 94
- Barytes,  
crystal form, 1, 303  
microwave birefringence, 5, 22
- Basal plane, 7, 350-351
- Base catalysis, 6, 102  
of mutarotation, 7, 383
- Baseball, 7, 104
- Bases,  
neutralisation, 6, 96  
optically active, 6, 33-41
- Basic carbonates, 1, 332  
copper nitrate, 2, 210

**Basic carbonates—*cont.***

- salts, 2, 210
- Bat hair, 4, 186
- Bath gas, 4, 455; 5, 157–161; 6, 249
  - analysis, 5, 158
  - argon in, 5, 159
  - composition, 7, 67
  - helium in, 5, 157–161
  - hydrocarbon in, 5, 159
  - inert gases in, 5, 468
  - neon in, 5, 159–160
  - rate of evolution, 5, 158
- Bath springs, salts in, 5, 158
- Bathing, 2, 276
- Batrachite, 1, 331
- Battery,
  - copper-zinc, 3, 93
  - flame, 1, 113–114
- Beam mirror, 4, 360
- Beam viscous, 6, 71–73
- Bearing friction, 3, 452
- Bearings, 4, 433
- Beats, 4, 384
  - pendulums, of, 8, 200–205
- Beaver's fur, 2, 277
- Bee,
  - sting, 4, 186
  - wing, 4, 186
- Beef-broth medium, 7, 84
- Beer, foaming, 4, 26
  - refractive index, 6, 166
- Beet, sugar, 3, 30–35
- Beetle,
  - colour, 9, 23, 261–262
  - eye, 4, 186
  - metallic, 9, 261–262
- Beetroot, rubidium in, 2, 320
- Beidellite, 10, 291
- Belenite, 4, 186
- Bell, 8, 205
  - metal, 9, 214
  - musical, 1, 246
- Belly, 8, 207–211
- Bending of bonds, 9, 506
  - mirrors in hydrogen, 4, 370–371
  - viscous bars, 6, 71–73
- Benic acid, 1, 546–547
- Bennet's doubler, 3, 467
- Bentonite, 10, 158, 291
- Benzaldehyde, 6, 12
  - infrared transmission, 8, 286

**Benzamide, 1, 157****Benzene, 1, 161**

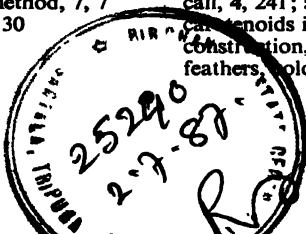
- argon, action of, 4, 406
- benzoic acid, from, 3, 362; 9, 99
- bond angle, 9, 509
- bromination, 3, 548–549
- carbon, effect on, 8, 295
- C-C distance, 9, 509
- charcoal, adsorption on, 6, 106
- chemical properties, 1, 405–408
- chlorination, 9, 99
- coal, from, 1, 399, 570; 9, 336
  - tar, from, 2, 184; 3, 336; 9, 100
- colour, 6, 415
- critical constants, 3, 315
- derivatives, 3, 362–364
- deuterium exchange, 10, 61–64
  - substituted, 10, 63–64
- dielectric properties, 9, 462–463
- discovery, 1, 570; 2, 56, 241–245;  
3, 362; 4, 157; 9, 98–100
- discharge, in, 7, 70
- dyes, 3, 368
- electron diffraction, 9, 361
- flame, 5, 33–34
- formula, 1, 156
- hexahydroxy-, 4, 207
- history, 3, 362–364
- industrial nitration, 1, 569–570
- infrared,
  - absorption, 1, 493; 8, 283–285
  - spectrum, 3, 213–214
- intermolecular distance, 9, 509
- light scattering, 2, 172
- magnetism, 10, 147
- melting point, 9, 99
- molecular refraction, 6, 156–162
- molecular structure, 1, 404; 3, 545–  
546; 6, 159–160, 410–417;  
8, 382; 9, 501
- mutarotation, 7, 384
- nitration, 1, 406; 3, 363
- nitrogen, and active, 7, 309–310
- petroleum, in, 9, 164
- preparation from phenol, 2, 245
- pressure and melting point, 7, 17
- refractive index, 2, 544–545
- ring, 8, 382
- solvent for rubber, 1, 406
- sound from, 3, 152
- spectrum, 7, 363

**Benzene—cont.**

- structure, 1, 404; 3, 545–546; 6, 159–160, 410–417; 8, 382; 9, 509
- colour, and, 9, 19–20
- synthesis, 1, 274, 478; 2, 145, 244
- ultraviolet absorption, 1, 430–431; 9, 20
- vapour density, 2, 146; 9, 99
- diffusion through rubber, 7, 471
- pressure, 7, 13
- ultraviolet absorption, 1, 430–431
- viscosity, 5, 142–154; 6, 67–73
- and pressure, 5, 144
- X-ray diffraction, 9, 1
- Benzilidene dichloride, 3, 166
- Benzoic acid, 1, 76–77, 155
  - amino, 3, 163
  - conversion to benzene, 3, 362; 9, 99
  - crystal structure, 9, 43
  - crystallisation, 7, 325
  - decomposition, 1, 570
  - distillation with lime, 3, 362; 9, 99
  - flakiness, 9, 43
  - formula, 1, 272
  - infrared transmission, 8, 286
- Benzoic anhydride, 1, 76–77
- Benzonitrile, 1, 157
  - infrared transmission, 8, 288
- Benzophenone, 3, 363
  - supercooling, 7, 120–121
- Benzopurpurin colloid,
  - rigidity, 9, 177
  - streaming birefringence, 10, 165
  - viscosity, 9, 173–181
- Benzopurpurin tactoids, 10, 169–170
- Benzoyl chloride, 1, 76–77
- Benzoylbenzoic acid, 5, 529
- Benzthiazoles, 10, 133
- Benzyl,
  - azide, 7, 198
  - cyanide, 8, 288
- Bequerel rays, 4, 509; 5, 78–80; 6, 17–23, 40
  - properties, 4, 502
- Bergamot oil, 5, 259
- Bergius process, 9, 329–336
- Beri-beri, 8, 375
- Berkeley and Hartley's method, 7, 7
- Berthollet's law, 1, 127–130
- Beryl,
  - cleavage, 4, 121

**Beryl—cont.**

- microwave birefringence, 5, 22
- Beryllium,
  - atomic heat, 5, 191; 7, 401
  - radius, 8, 326; 9, 502
  - structure, 8, 221–226
  - volume, 7, 401
- deuteron bombardment, 10, 109
- electron diffraction, 9, 19
- ionic radius, 9, 86
- neutron from, 9, 415–418; 10, 408–411, 496
- nuclear fission, 9, 15–16
- oxide, 7, 130
- $\alpha$ -particle bombardment, 9, 414–418
- recoil, 8, 250
- Berzelius electrochemical theory, 1, 136–139
- Bessemer process, 1, 512–513; 3, 448
- Beta particles (*see particles*)
- Betelgeus, 1, 433–434
- Biaxial crystals, 1, 298–304; 2, 357–361; 4, 124; 5, 541–542
  - magnetic properties, 9, 140
- Bicarburet of hydrogen, 9, 98–100
- Bicycle, 3, 316
- Biebrich scarlet, 3, 368
- Bignonia chica, 9, 121
- Bilberry, 9, 115
- Bill pigments, 4, 235
- Billiard ball, 8, 346
- Binary stars, 4, 350
- Binocular vision, 4, 394; 5, 435–436
- Biochemical mechanisms, 8, 26–31
- Biogenesis of carotenoids, 10, 236–237
- Biological effect of heavy water, 10, 20
  - low temperature, 4, 222
  - temperature, 5, 470–472
  - ultrasonics, 9, 292–296
- Biological molecules, 9, 446–464
- Biosynthesis, 1, 272
- Biphenyl, 10, 146
- Biphosphate of sodium, 2, 207
- Biquartz, 7, 340
- Bird,
  - call, 4, 241; 5, 476–482; 6, 56
  - carotenoids in, 10, 235–236
  - construction, 5, 476
  - feathers, colour, 9, 18



**Bird—*cont.***

flight, 5, 294

**Birefringence**, 1, 5; 2, 332–333; 4,

114; 5, 544

crystals, of, 2, 272; 5, 544–580; 7, 329

infrared, 2, 332–333

liquid crystals, of, 7, 331

magnetic, 6, 201–204; 10, 165

microwave, 5, 20–23

molecular refraction, and, 2, 138–139

polarisation, 5, 544

shearing and liquids, 9, 168–169

soap solutions, of, 9, 65–72

strain, 7, 329

in colloids, 9, 167

streaming, 10, 165–167

sulphates, of, 9, 81

tactoid, 10, 167–170

theory, 3, 530–531

tobacco mosaic virus, of, 10, 220–222

**Birkeland and Eyde process**, 6, 181**Birotation**, 7, 381**Birth of stars**, 8, 237, 243**Bismark brown**, 3, 368**Bismuth**,

A.C. magnetic field, in, 8, 501

alloys, 9, 424–425

antimony thermocouple, 5, 66

atomic heat, 5, 190–191; 7, 401

refraction, 2, 540

volume, 7, 401

weight, 1, 500–508, 535; 2, 325, 540; 5, 190

bacteria, action on, 7, 86–92

photographic plate, 2, 257–258

breaking stress, 4, 269

and temperature, 5, 462–464

carbonate, basis, 1, 332

cleavage planes, 9, 147

density and pressure, 9, 152

of electrons in, 8, 142

deuterium bombardment, 10, 253

diamagnetism, 1, 189–195; 9, 142–154

discovery, 2, 315–316

disintegration of radioactive, 8, 133

gold alloy, 9, 424

impurities, effect of, 5, 459

**Bismuth—*cont.***

isotopes, 8, 457

lead alloy, 9, 424

thermocouple, 4, 538

magne-crystals, 2, 88–96; 9, 138–140

magnetism, 1, 68–70, 145, 150–153; 4, 534–535

nitrate, basic, 1, 333

oxide, 5, 164

peroxide, 1, 282

pressure, effect of, 9, 150–151

proton bombardment, 9, 498

purification, 4, 533–534

radioactive, 5, 523; 8, 122

radium E, and, 8, 122

resistance and temperature, 4, 524–534; 5, 459

in magnetic field, 4, 534–535; 5, 459

silver couple, 9, 225

single crystal, 9, 137–138

magnetic properties, 1, 193–195

specific heat, 2, 325

surface tension of liquid, 4, 118

thermal conductivity, 6, 213

expansion, 8, 382

thermopile, in, 3, 270–271

tin alloy, 5, 191

trace in explosion, 3, 446–450

tree, 2, 338

trichloride, 1, 536

triethyl, 1, 536

vibrations from, 1, 109

X-ray diffraction, 9, 152

Young's modulus, 8, 354–355

**Bismuthous acid**, 1, 333**Bistriazoethane**, 7, 198**Bitter almond oil**, 1, 272; 3, 372**Bitumen**, 4, 42**Bjerknes apparatus**, 4, 333**Black**,

aniline, 2, 506–509

background, 8, 311–312

body,

colour and temperature, 7, 238

emissivity, 8, 290

radiation, 1, 42–48; 8, 276–278; 9, 182

law, 8, 106

theory, 7, 446

**Black—cont.**

- diamond, 7, 34
- dyes, 6, 417
- films,
  - gas diffusion through, 8, 173–176
  - plane, 8, 136–142
  - structure, 9, 37–47
- glass, 9, 163
  - infrared transmission, 1, 496
  - polariser, 3, 519
- grapes, 9, 115
- laquer, 3, 363
- mica, 8, 289
  - infrared transmission, 1, 496

**Blackened thermometer, 1, 42****Blackley blue I, 3, 368****Blackley blue R, 3, 368****Blackley orange, 3, 368****Bladder, osmosis, 7, 5****Blast-furnace, 3, 361–362**

- chemistry, 4, 208

- gas, 7, 417

- oxides in, 4, 213

**Bleaching,**

- chlorine, by, 1, 155; 2, 266

- effect of light 1, 257

- flour, of, 7, 368

- hydrogen peroxide, by, 1, 155

- magenta, of, 1, 410

- ozone, by, 1, 23; 2, 363 ✓

- powder, 2, 266

**Blende,**

- cleavage, 4, 120

- structure, 7, 331, 337

- X-ray diffraction, 7, 340–354

**Bleu de Lyon, 2, 188****Blood,**

- charcoal, 6, 406

- corpuscles, effect of ultrasonics, 7, 293

- pH, 9, 320

- pigments, 4, 235

- protein, 10, 217

- refractive index, 6, 166

- serum, 10, 414

- spectrum, 1, 484

- viscosity, 9, 170

**Blossoms, colour, 9, 114–121****Blowfly proboscis, 4, 186****Blowing,**

- fuses, of, 4, 330

**Blowing—cont.**

- glass, 7, 385

**Blowlamp, 7, 237****Blowpipe,**

- effect on flames, 2, 33–35

- flame, 3, 178

- hydrogen-oxygen, 9, 96

**Blue,**

- butterflies, 9, 261–262

- cornflower, 10, 113

- cyanin in, 9, 115

- ocean, colour of, 2, 254–264

- Runge's, 2, 185

- sky, 2, 15–21, 171–177; 8, 308–317; 9, 268–288

- artificial, 3, 247

- sun, 2, 21

- vitriol, 4, 114

- water-gas, 1, 417

**Blueprints, 4, 42****Board of Trade ohm, 4, 427**

- reflection of Hertz waves, 4, 346

**Boat screw, 7, 431****Boath's telephone, 8, 369****Bode's law, 8, 224****Body-centred cube, 7, 347****Bochmeria nivea, 5, 23****Bohr,**

- magneton, 9, 91

- prediction of Lyman series, 8, 108

- radius, 8, 59, 226

- and atomic number, 8, 227

- theory, 8, 42–45

- and Rydberg constant, 8, 229

**Boiler, 2, 276**

- design, 3, 388–389

- steam, 7, 419–430

- bromine, of, 1, 469–470

- point,

- chemical structure, and, 2, 182

- elevation, 5, 494

- sulphuric acid, of, 1, 467

**Boiling, ultrasonics, by, 9, 291****Bolometer, 4, 333, 341; 8, 237**

- infrared detector, 9, 223

**Bomb, high pressure, 6, 312; 8, 463****Bombardment,**

- deuteron, 10, 22–27, 109, 252–253

- neutron, 9, 496; 10, 253–256

- proton, 9, 496–499; 10, 22–23, 252–253

- Bombardon, 8, 207**  
**Bond,**  
     bending, 9, 506  
     peptide, 10, 440  
     strength in diamond, 9, 509  
     stretching, 9, 506  
**Bonecourt system, 7, 410-430**  
**Bones, X-ray opacity, 4, 486**  
**Book, microwave polarisation by, 5, 25**  
**Boomerang, 1, 118-119**  
**Boracic acid, 1, 333**  
**Boracic ether, infrared absorption, 1, 391**  
**Borax,**  
     beads, 9, 159  
     optical properties, 1, 299  
     supersaturation, 1, 135  
     surface tension of molten, 4, 118  
     ultraviolet absorption, 1, 430-431  
     use in dyeing, 3, 170  
     X-ray diffraction, 7, 353  
**Bordeaux,**  
     cornflower, 9, 115  
     red, 3, 368  
**Bores, 7, 431**  
**Boric acid, 9, 396**  
**Boric oxide, 9, 159**  
**Borides, 9, 424**  
**Borneo petroleum, 9, 104**  
**Borneol, 6, 12**  
**Boron,**  
     allotropy, 1, 56-58  
     atomic heat, 5, 191; 7, 401  
         radius, 9, 502  
         refraction, 2, 540  
         structure, 8, 221-226  
         volume, 7, 401  
         weight, 1, 500-508; 2, 540; 8, 540  
     discovery, 2, 315-316  
     electron diffraction, 9, 191  
     fluoride, 8, 339  
     fluorine, action of, 5, 96  
     glass, 3, 220; 5, 445  
     isotopes, 8, 340  
     mass spectrum, 8, 340  
     nitride, 2, 196-197  
     nuclear fission, 9, 13-16  
     proton bombardment, 9, 496-497  
     recoil, 8, 250  
     trichloride, 2, 196-197  
         molecular structure, 9, 504  
**Boron—cont.**  
     trichloride—*cont.*  
         reaction with ammonia, 2, 197  
**Bort, 7, 34**  
**Boscovitch atoms, 5, 331**  
**Bottomley's radiation law, 5, 237-240**  
**Boundary,**  
     lubrication, 9, 46  
     moving, 5, 493-494  
**Bourdon gauge, 6, 312**  
**Bow, violin, 1, 246-248**  
**Bowed strings, 8, 207**  
**Boyle's law, 2, 243; 4, 101**  
**Boyle's work on phosphorous, 4, 13-14**  
**Boy's torsion balance, 4, 355**  
**Boy's measurement of G, 5, 299-300**  
**Box,**  
     detonation, 9, 471-472  
     myrtle, 9, 116  
     pump, 9, 237  
**Boxwood charcoal, 6, 103-106, 395**  
**Bragg theory of X-ray diffraction, 7, 345-347, 447-448**  
**Brandy, 5, 259**  
**Branching-chain reactions, 9, 218**  
     tracks, 9, 417; 10, 37-38  
**Brain, 5, 419**  
**Brass,**  
     bacteria, action on, 7, 86-92  
     breaking stress, 4, 267  
     crystal structure, 9, 215  
     electrodes, 3, 107-108  
     emissivity, 8, 290  
     heat of formation, 3, 234  
     instruments, 8, 205-207  
     melting, 7, 419  
     specific heat, 6, 85-87  
     thermal conductivity, 6, 213  
     vacuum vessels, 6, 218  
**Braun's measurement of G, 5, 300**  
**Bravais lattice, 7, 330**  
**Breadth of spectral lines, 8, 236-243**  
**Break of cricket ball, 7, 106**  
**Breakdown, dielectric, 3, 98-104**  
**Breaking stress, 4, 267-270; 5, 462; 6, 425-426**  
     of alloys, 6, 425-426  
**Breech blocks, 8, 438**  
**Breeding,**  
     cattle, of, 2, 276



**Breeding**

- natural indigo, 9, 102
- sugar beet, 9, 102

**Brewster's angle, 7, 98**

- and refractive index, 2, 170

**Brick,**

- microwave absorption, 5, 17
- softening point, 7, 237

**Brickwork, 3, 351****Bridge, 5, 448-449; 8, 207-211, 361**

- Elliot, 4, 521

- Wheatstone, 2, 348; 3, 320; 4, 520-521

**Bright field illumination, 6, 123****Bright spot, demonstration in shadows, 6, 55-56****Brightness, measurement of sun's, 3, 427-437****Brilliant green, 3, 368****Britannia violets, 2, 188****British,**

- economic power in 1851, 1, 34-41
- natural resources, 1, 35
- units, 3, 228-229

**Brittleness, 8, 346, 361-362****Broadening of spectral lines, 3, 443****Broglie wavelength, 9, 207-213, 358****Bromic acid, 1, 333****Bromides, viscosity, 5, 141-154****Bromination of benzene, 3, 548-549****Bromine,**

- atomic heat, 7, 401
- radius, 8, 326; 9, 502
- refraction, 2, 138, 540
- spectrum, 3, 125
- volume, 7, 337, 401
- weight, 1, 500-508; 2, 540; 8, 340
- boiling, 1, 496-470
- charcoal, adsorption by, 6, 106
- discovery, 2, 316-317
- dissociation, 3, 126; 9, 221
- infrared transmission, 1, 390; 8, 284
- ionic radius, 9, 86
- isotopes; 8, 339-340
- liberation of, 1, 155
- light emission, 5, 27
- mass spectrum, 8, 339-340
- molecular spectrum, 3, 125
- photochemistry, 1, 202
- reaction with nickel carbonyl, 4, 209

**Bromine—cont.**

- ultraviolet absorption, 3, 262
- vapour density, 3, 126
- sound from, 3, 157
- spectrum, 3, 125
- viscosity, 5, 141-148
- Bromoacetic acid, 7, 198
- Bromobenzene, 2, 145
- infrared transmission, 8, 286
- Bromobutyric acid, 8, 287
- Bromocamphor, 8, 288
- Bromocamphor sulphonic acid, 6, 33
- Bromoethylamine, 7, 204
- Bromonaphthalene, 8, 286
- Bromonitrocarnphor, 7, 382
- Bromopropionic acid, 7, 198
- Bronze, 9, 214
- aluminium, 3, 507-508
- crystal structure, 9, 215
- hardness, 9, 2
- Brookite, 1, 299-301
- structure, 7, 336
- Broth medium, 7, 84
- Brown Y, 3, 368
- Brownian motion, 7, 164-183
- Einstein theory, 7, 180
- rotational, 7, 180
- tobacco smoke, of, 7, 165
- viscosity, and, 7, 165
- Brucine, 9, 198
- Brucite, 5, 23
- structure, 10, 288-292
- Brunolic acid, 1, 400
- Brush discharge, 4, 173-174
- effect on X-rays, 4, 503
- Bubbles, 8, 66-99, 136-178; 9, 38-39, 109; 10, 446-457
- absorption of water, 8, 89-99
- chains of, 8, 142-152
- coherence, 5, 233
- collodion films, in, 8, 4-6
- columns of, 8, 142-152, 162-173
- concentric half, 8, 156-158
- contraction, 8, 87-89
- distortion, 8, 71-73
- drainage of, 8, 89-99
- duration, 8, 73-78
- extensibility of columns, 8, 162-176
- formation in ice, 1, 252-255

**Bubbles—*cont.***

- gas diffusion through, 8, 78–87, 166–173
- high-pressure, 8, 176–178
- hydrogen, 8, 176–178
- large, 8, 136
- liquid air, from, 8, 69–71
- long duration, of, 8, 386–448
- multiple column, 8, 148–152
- photography, 4, 61
- soap-glycerine, 8, 71–79
  - pressure in, 1, 131
  - thickness, 3, 234–237
- stability, 9, 111–112
- symmetrical clusters, 8, 152–156
- wire frames for, 8, 159–162

**Buckwheat, 9, 116****Buffers, 5, 498; 9, 322****Bulbs, phosphorescent, 4, 182****Bulby layer, 10, 250****Bulk modulus, 8, 346–362**

- measurement, 8, 348–349

**Bullet, compression by, 8, 303–308****Bumping, 1, 467–474****Bunsen flame,**

- conductivity, 7, 1–4
- spectra, 3, 448
- temperature, 7, 237

**Burner,**

- atmospheric Teclu, 9, 472
- regenerative, 7, 46

**Burning-glass, 9, 94**

- of diamond, 9, 94–6

**Bursting of collodion film, 8, 6****Bushrope, 9, 121****Butane, 1, 273**

- formula, 1, 545
- isomers, 2, 481–482, 486
- molecular structure, 1, 403, 562
- normal, 2, 481, 486
- synthesis, 1, 91; 2, 489–492

**Butene,**

- discovery, 3, 362
- formula, 2, 193

**Butyl alcohol, 1, 479, 546**

- extraction by, 10, 115–116
- infrared transmission, 8, 286
- normal, 2, 483, 486–487
- viscosity, 5, 142–154

**Butyl nitrite, 2, 172****Butyl phthalate, 9, 243–244****Butylene, 2, 193****Butyric acid, 1, 274, 479**

- formula, 1, 546–547
- infrared transmission, 8, 287
- isomers, 2, 482
- viscosity, 5, 142–154

**Butyronitrile, 8, 288****Butter,**

- carotene in, 10, 239–243
- colour, 10, 239
- fat in milk, 5, 452
- refractive index, 6, 166
- vitamin A in, 8, 375, 377; 10, 239–243

**Buttercup, 10, 234****Butterfly,**

- blue, 9, 261–262
- colour, 9, 18–25
- tortoiseshell, 9, 261
- wings, 5, 259

**Buxton springs, 4, 455****C****C.G.S. unit of charge, 5, 552**

- units, 3, 92

**Cables,**

- effect of pulse, 4, 421
- submarine, 6, 361–367

**Cacodyl, 1, 139****Cadinene, 6, 12****Cadmium,**

- atomic heat, 5, 191; 7, 401
- radius, 8, 326
- refraction, 2, 540
- volume, 7, 401
- weight, 1, 500–508; 2, 316–317, 325

**bacteria, action on, 7, 86–92****expansion, 4, 462****iodide, 9, 81****ionic radius, 9, 86****lead couple, 4, 538****magnesium arc, 7, 82****permanganate, 6, 100****photographic plate, action on, 5, 257****potassium iodide, 5, 491****resistance, 4, 524–527****rigidity, 8, 360**

**Cadium—cont.**

- specific heat, 2, 325, 541
- sulphide,
  - crystal structure, 7, 130
  - phosphorescence, 3, 47
- trace in explosion, 3, 445–450
- tree, 2, 338
- Young's modulus, 8, 354–355
- Zeeman effect, 5, 274; 6, 208

**Caesium,**

- atomic heat, 7, 401
- radius, 8, 326
- spectrum, 3, 66–79
- volume, 7, 401
- weight, 1, 500–508; 2, 540
- chromate, 7, 327–328
- discovery, 1, 356, 509; 2, 316–320
- ionic radius, 9, 86
- magnesium silicate, 5, 544, 548
- mineral, 1, 509
- occurrence, 1, 509; 2, 320
- perchlorate, 7, 327–328
- properties, 2, 319
- selenate, 5, 539, 549
  - crystal form, 7, 327–328
- spectrum, 1, 356; 2, 318–320
- sulphate, 5, 539
  - crystal form, 7, 327–328
- zinc sulphate, 5, 540 ✓

**Caffeine, 2, 242****Cage effect, 1, 143–144**

Faraday, 4, 93

**Cagnard de la Tour, 2, 294–295; 5, 361****Cailletet pump, 3, 194****Calc-spar (see calcite)****Calcareous spar (see calcite)****Calcined favina, 3, 170****Calcite (see also Iceland spar and calcium carbonate)**

- allotropy, 1, 36
- cleavage, 4, 121; 9, 149–150
- crystal form, 1, 303
  - structure, 8, 323–325, 328–329; 9, 83, 87
- diamagnetism, 1, 192
- expansion, 4, 462
- Fontainbleau, 4, 55
- free calcium in, 9, 166
- lens, 8, 316
- magnetic properties, 1, 9, 192–195

**Calcite—cont.**

- microwave birefringence, 5, 22
  - optical properties, 1, 5
  - polariscope, in, 4, 187
    - magnetic field, 9, 136–137
  - polariser, 3, 519
  - prism, 8, 316
  - refractive index, 9, 462–463
  - shortage, 7, 371–372
  - sodium nitrate crystallisation on, 7, 326–328
  - X-ray diffraction, 7, 453
  - zoned crystals, 4, 52
- Calcium, 1, 284–289**
- abundance, 10, 272
  - acetate, 3, 363
  - aluminium silicate, 1, 331
  - atomic heat, 7, 401
    - radius, 8, 326
    - refraction, 2, 540
    - spectrum, 3, 72–78, 186–203
    - volume, 7, 401
    - weight, 1, 500–508; 2, 325, 540
  - benzoate, 3, 363
  - butyrate, 2, 482
  - carbonate,
    - basic, 1, 332
    - Bath springs, in, 5, 158
    - birefringence, 2, 138–139, 169, 274, 332–333
    - chromatography, in, 10, 229
    - cleavage, 9, 149–150
    - crystal structure, 8, 319, 323–325, 328–329; 9, 83, 87
    - decomposition, 2, 422; 7, 493
    - diamagnetism, 1, 192
    - expansion, 4, 462
    - infrared birefringence, 2, 332–333
    - insulation, 5, 164
    - magne-crystals, 2, 88–96
    - magnetic field, in, 9, 136–137
    - magnetic properties, 1, 193–195
    - optical properties, 2, 395–397
    - polarisation of light, 2, 169
    - sodium nitrate crystallisation on, 7, 326–328
    - ultraviolet absorption, 1, 430–431
  - carbonyl, 4, 208
  - cathode, 6, 243
  - chloride,
    - alcohol of crystallisation, 2, 209

**Calcium—cont.****chloride—cont.**

- colligative properties, 7, 14
- density, 6, 6
- electrolysis, 1, 287
- expansion, 6, 6
- osmosis, 2, 217
- reaction with aniline, 1, 407
- solubility, 3, 394
- solution, diffusion through
  - rubber, 7, 484–485
- specific heat, 6, 85–87
- use of as desiccant, 2, 401
- water eutectic, 2, 522
  - phase diagram, 2, 523

discovery, 2, 315–317

earth's crust, in, 7, 54

electron diffraction, 9, 191

**fluoride,**

- crystal structure, 8, 321–323
- electrolysis, 5, 89–91
- insulation, 5, 164
- occurrence, 5, 84
- purification, 5, 89

fluorophosphate, 2, 126–127; 5, 84

**free,**

fluorspar, in, 9, 166

glass, in, 9, 166

Iceland spar, in, 9, 166

hypochlorite, 1, 410

**hydroxide,**

- use in manganese dioxide re-generation, 2, 268–269
- water softening, 2, 262–264

ionic radius, 9, 86

iron spectrum, 3, 189

isobutyrate, 2, 482

magnesium silicate, 1, 331

nitrate, 1, 129–130

alcohol of crystallisation, 2, 209

in Bath springs, 5, 158

production, 6, 182

**oxide,**

cathode, 6, 167; 7, 36–37

use as desiccant, 2, 401

$\alpha$ -particle bombardment, 9, 15–16

peroxide, 1, 282

phosphate, 5, 164

phosphide, 1, 207

production, 1, 287

properties, 1, 287

**Calcium—cont.**

pyrophosphate, 2, 502

pyrovanadate, 2, 502

rickets, and, 8, 375

silicate, 1, 331; 7, 57

spectrum, 1, 354–359, 384, 433

specific heat, 2, 325

sulphate in Bath springs, 5, 158

optical properties, 2, 177

precipitation, 2, 134–135

solid solutions, 5, 37

solubility, 3, 394

**sulphide,**

infrared detector, 9, 223

glass, 9, 160

nickel in, 9, 223

phosphorescence, 1, 310–312; 4, 508

temperature, and, 7, 81

phosphors, 3, 252

radioactivity, effect of, 5, 560

sun, in, 1, 433

toluene sulphonates, 3, 373

trace in explosion, 3, 444–450

tungstate, 4, 508

ultraviolet spectrum, 3, 259–266

Zeeman effect, 6, 208

Calculation of critical constants, 3, 316

helium emission from radium, 7, 76–79

mutual inductance, 4, 445

**Calico,**

bleaching, 2, 266

membrane, albuminated, 2, 217

Callistephin, 10, 120

Calorescence, 1, 534

Caloric, 1, 346

Carnot's cycle, and, 6, 349–350

early definition, 2, 148

Joule, and, 4, 2–6

theory, 4, 275; 5, 359–360; 6, 349–350

**Calorimeter,**

charcoal, 6, 229–230

ice, 5, 189–191; 6, 74

Joly's, 5, 193

liquid air, 6, 78–81, 430; 7, 232–234

liquid ethylene flame, 4, 470

liquid hydrogen, 6, 74–89

**Calorimeter—*cont.***

- low-temperature, 7, 391–401
- vacuum, 5, 364
- Calorimetry, 5, 189–193; 6, 74
- Calotype process, 4, 41
- Campbelline, 3, 368
- Camera,
  - high speed, 9, 474–475; 10, 11
  - pinhole, 4, 70
- Camphene, 6, 12
- magnetism, 1, 68
- Camphor,
  - acid derivatives, 6, 33
  - azo-derivative, 7, 201
  - infrared transmission, 8, 288
  - magnetism, 1, 68
  - motion in water, 4, 30–31; 6, 15
  - optical rotation, 3, 516; 7, 380
  - phosphorous glow, and, 9, 27
  - volatility, 2, 400
  - water foam, 4, 27
- Canada balsam, 3, 522
- in coherers, 4, 336
- Canadine, 7, 364–367
- Canalstrahlen (*see kanalstrahlen*)
- Canary, 10, 236
- Cancer, 6, 49
- Candle flame, 1, 277, 318; 2, 152
  - carbon particles in, 1, 363
  - introduction of air into, 1, 663
  - low pressure, at, 1, 360–364
  - moving, 2, 32
  - sound from, 3, 155
  - source of luminosity, 1, 363
  - ultraviolet spectrum, 3, 260–261
- Candle phosphorescence, 7, 81
- Cane-sugar,
  - boiling point elevation, 7, 14
  - charcoal, 6, 107
  - formula, 9, 50
  - freezing point depression, 6, 97–98; 7, 14
  - inversion, 5, 498
  - osmosis, 7, 14
  - polaroscope, in, 4, 187
  - solution,
    - diffusion through rubber, 7, 485
    - relative viscosity, 9, 168
  - spectrum, 7, 358
  - X-ray diffraction, 7, 353
- Cantharidine, 2, 303

**Capacitance,**

- discharge of, 7, 278–285
  - discovery, 2, 78–82
  - inductance circuits, 3, 483; 8, 201–202
  - insulated wire in water, of, 1, 98–99
  - Leyden jar, of, 3, 94
  - measurement, 3, 92
  - oscillation frequency, effect on, 3, 483
  - standard, 5, 452
  - transmission of electricity, effect on, 1, 99–105
- Capacitor,**
- breakdown, 3, 95
  - energy of charging, 3, 95
- Capacitors in series, 3, 100–101
- Capella, 1, 433–434
- Capers, 9, 116
- Capillarity, 3, 227–256, 325–349; 6, 15–16, 98; 8, 1–26, 511; 10, 1–14
- theory, 3, 326–327; 8, 511
- Capillary tube,
  - passage of liquids through, 2, 211–213
  - vascometer, 9, 169
- Capri, 7, 94
- Caprioc acid, 1, 274, 479
- Caproylene, 1, 399
- Caprylic acid, 1, 546–547
- Capture of  $\alpha$ -particles, 9, 75–76
- Caramel, 2, 216–217
- Carajura, 9, 121
- Carajuretin iodide, 9, 121
- Carajurin, 9, 121
- Carbides, 9, 424
- Carbohydrates, 9, 48–62
  - classification, 9, 50
  - hydrolysis, 9, 50–51
  - photosynthesis, 9, 193–200
- Carbon,**
- absorption of chlorine, 3, 543–544
  - (acetylene) spectrum, 3, 80
  - adamantine, 4, 535
  - allotropy, 1, 56–58; 7, 22 23
  - and pressure, 8, 294
  - amorphous, 8, 320
  - arc, 8, 240
  - apparatus, 3, 204
  - spectra, 3, 174–175

**Carbon—*cont.*****arc—*cont.***

- spectroscopy, for, 3, 72–73
- atom configuration, 5, 195
- atomic heat, 5, 191; 7, 401
  - radius, 8, 326; 9, 502
  - refraction, 2, 138, 541; 6, 162
  - spectrum, 8, 371
  - structure, 8, 221–226
  - volume, 7, 336, 401
  - weight, 1, 500–509; 2, 541; 8, 340
- atoms, asymmetric, 6, 31
- band spectrum, 8, 371
- carbon bond lengths, 9, 463–464
- colour, 6, 414–417
- combustion in liquid oxygen, 4, 463
- compounds,
  - number, 9, 18
  - spectra, 3, 174–186
- compression, 7, 335
- diamond-graphite conversion, 5, 103
- dioxide, 1, 158
  - adsorption on charcoal, 6, 105, 384, 395–404
    - heat, 6, 255
  - air, diffusion into, 5, 374
  - alcohol bath, 8, 272
    - diffusion through rubber, 7, 485–486
  - alkali, rate of absorption by, 5, 375
- Andrews data, 2, 294–301
  - work, 4, 108
- apertures, through, 5, 397–390
- Bath gas, in, 5, 158
- boiling point, 6, 77; 7, 143, 237
- biosynthesis, in, 1, 272
- carbon arc in, 3, 176
- coal, from, 1, 399
  - fermentation, 1, 56
- cooling agent, 4, 458
- critical constants, 2, 294–301; 3, 315
  - opalescence, 2, 276
  - temperature, 4, 108
- density,
  - in charcoal, 6, 218
  - of solid, 6, 5, 77; 7, 143
- dielectric breakdown, 3, 102
- discovery of solid, 4, 160; 5, 361

**Carbon—*cont.*****dioxide—*cont.***

- dissociation, 3, 380–386, 474; 5, 244–247; 7, 406
- effusion rate, 2, 40–44, 224–229
- electric discharge in moist, 3, 199–200
- ethane, in,
  - explosion, 6, 313
  - flame, 6, 303
- ethylene flame, in, 6, 303
- evaporation temperature, 7, 226
- expansion coefficient,
  - liquid, of, 5, 284; 6, 5
  - solid, of, 6, 5
- expiration in treadmill, 1, 378
- fluid state, 4, 104
- glow discharge strata, 3, 115–120
- graphite, through, 1, 41–44, 224–229
- heat of adsorption, 6, 109–110
- hydrogen, diffusion into, 2, 221–222
- infrared absorption, 1, 349, 463–466; 3, 274–275
- infrared spectrum, 9, 225
- ion, 7, 186–187
- Joule-Thompson effect, 4, 5
- latent heat, 6, 77, 431
- leaves, through, 5, 372–391
- liquefaction, 3, 29; 6, 36
  - in jet, 4, 464
- liquid, 4, 457
- magnesium arc in, 3, 187–188
- magnetism, 1, 68
- mass spectrum, 7, 186–192; 8, 336–337
- melting point, 7, 143
  - and pressure, 7, 20–21
- molar refraction, 2, 137
- molecular structure, 9, 504
- molecular volume, 6, 8–9
- occlusion by,
  - gold, 2, 47
  - iron, 2, 48, 233–239
  - silver, 2, 47
  - pressure, 6, 254
- paramagnetism, 4, 220
- phosphorous glow in, 5, 28–29
- photochemical reduction, 9, 194

**Carbon—*cont.*****dioxide—*cont.***

- photosynthesis, in, 5, 372; 9, 193–200
- plants, rate of absorption by, 5, 375
- ratio of specific heats, 5, 337
- reaction with metal-organic compounds, 1, 480
- rubber, through, 2, 38–44, 229–233; 7, 471–486
- silicon, analogy to, 7, 56–59
- solid, 2, 294, 312–313
  - alcohol bath, 8, 272
  - at  $-200^{\circ}$ , 6, 5
  - ether bath, 3, 23
- sound from, 3, 152
- specific heat of solid, 6, 85–87
- spectrum, 3, 512
- thermal decomposition, 2, 149
- thermometer, 7, 224
- ultraviolet absorption, 1, 430–431
- vibrationally excited, 8, 468–469
- viscosity, 2, 219–221
  - pressure of liquid, and, 5, 144
  - temperature, and, 5, 248
- volatility of solid, 2, 400
- water, diffusion through rubber, 7, 485–486

**disulphide, 1, 273**

- boiling by infrared, 2, 4
- boiling point, 7, 143
- carbon, effect on, 8, 295
- charcoal adsorption on, 6, 106
- chlorination, 1, 142
- chlorine, action of, 1, 477
- coal, from, 1, 399
- coal gas, in, 2, 353
- critical constants, 3, 315; 5, 361
- crystals, 4, 263
- decomposition, 8, 303
- density of solid, 7, 143
- dispersion, 3, 245–246
- flame, 1, 220; 2, 152; 5, 30; 9, 469–473
- hydrogen flame, and, 3, 260–261
- hydrogen, reaction with, 2, 354–358
- infrared absorption, 1, 349, 390, 493, 497, 532; 3, 274–275; 8, 284

**Carbon—*cont.*****disulphide—*cont.***

- infrared spectrum, 3, 213–214
- Kerr effect, 3, 479
- light scattering, 2, 172
- magnetism, 1, 68
- magneto-optical properties, 5, 170–188
- molar refraction, 2, 137
- nickel carbonyl, reaction with, 7, 143
- nitric oxide,
  - explosion, 2, 19
  - flame, 2, 152; 9, 469–471
  - velocity, 4, 143
  - vibrations, 4, 143
- nitrogen, and active, 7, 310–311
- ozone, action of, 3, 472; 7, 145–153
- phosphorous glow, and, 9, 27
- preparation, 1, 477
- prism, 5, 392
- refractive index, 3, 245–246
- solution of ozone, 7, 135
- sound from, 3, 152
- supersaturation, 1, 135
- ultraviolet absorption, 1, 430–431
- ultraviolet spectrum, 3, 263
- viscosity, 2, 219–221; 5, 141–154
- volatility, 2, 400
- water surface, 3, 332
- Dulong and Petit's law, 6, 88
- earth's crust, in, 7, 55
- electrical and optical properties, 1, 256
- electrodes, hydrogen in, 3, 178
- electron diffraction, 9, 191
- filament, 7, 46–47
  - hardening, 8, 295
- flames in, 2, 152
- fluorine, action of, 5, 96
- furnaces, 7, 239
- heats of combustion, 9, 464
- impurity in tantalum, 7, 48
- ion, 7, 186–188
- isotopic labelling, 10, 69–70
- lead couple, 4, 538
- mass spectrum, 8, 336–337
- mellitic acid from, 6, 413–414
- monosulphide, 7, 143–153
  - active nitrogen, from, 7, 311

**Carbon—*cont.*****monosulphide—*cont.***

- analysis, 7, 151–152
- chemical properties, 7, 152
- density of polymer, 7, 143
- monomer, 7, 145–153
- polymer, 7, 143–153
- preparation, 7, 143
- spectrum of explosion, 7, 150
- monoxide, 1, 158; 4, 205–217
  - boiling point, 7, 143
  - catalysed combustion, 7, 406–408
  - charcoal, adsorption by, 6, 105, 395
  - coal, from, 1, 399
  - density of solid, 7, 143
  - dissociation, 3, 380–386
  - ethane explosion, from, 6, 313
  - flame, 9, 471–491
    - effect of,
      - argon, 8, 475–487
      - hydrogen, 8, 471–473
      - nitrogen, 8, 475–487
      - water, 8, 468
    - photography, 9, 477–478
    - shock waves in, 9, 479–481
    - spin, 9, 483–491
    - under pressure, 8, 468
    - velocity, 4, 143, 145–146; 8, 469; 9, 468, 479
  - heat of combustion, 8, 468
  - high-pressure combustion, 8, 468–488
  - hydrogen-oxygen explosion, 1, 128
    - flame velocity, 4, 146
  - hydrogen synthesis, 9, 352–356
  - ignition temperature, 8, 468
  - infrared absorption, 1, 349, 463–466
  - intermediate in flames, 4, 147–149
  - ion, 7, 168–173
  - mass spectrum, 7, 187–192; 8, 336–337
  - mechanism of combustion, 8, 473–475
  - melting point, 7, 143
  - metals, reaction with, 4, 208
  - molar refraction, 2, 137
  - nitrous oxide flame, 4, 145
  - occlusion,

**Carbon—*cont.*****monoxide—*cont.***

- occlusion—*cont.*
  - gold, by, 2, 47
  - silver, by, 2, 48
- oxygen explosion, 6, 30
  - spectrum, 3, 446–447
  - temperature, 3, 449–450
- oxygen reaction, 7, 100–102
- paramagnetism, 4, 220
- poisoning of platinum, 9, 399
- potassium hydroxide, reaction with, 1, 479
- production on metal surface, 6, 300
- properties, 4, 205
- radiation form flame, 8, 468–469
- radical, 4, 205–207
- ratio of specific heats, 5, 337
- separation from coal-gas, 5, 157
- niobium alloy, 9, 424
- number of electrons, 8, 58
- occurrence, 9, 254
- oxygen reaction, 7, 100
- $\alpha$ -particle bombardment, 9, 15–16
- particles in air, 1, 424–425
- preferential combustion, 6, 302–303
- pressure, effect of, 8, 295
- protoplasm, in, 7, 61
- quartz, in, 9, 166
- recoil, 8, 246
- resistivity, 4, 518–535
- rings, 6, 408–409
- specific heat, 7, 233–234
  - and temperature, 6, 83–85
- spectrum, 1, 512
- steel, in, 1, 513
- sulphur mixtures, light sensitivity, 4, 336
- sun, in, 3, 175
- temperature, effect of, 8, 295
- tetrachloride, 1, 270; 2, 194
  - adsorption on charcoal, 6, 106
  - carbon, effect on, 8, 295
  - critical constants, 3, 325
  - crystals, 4, 263
  - discovery, 4, 157
  - electric discharge in, 3, 180–182
  - fluorine, action of, 5, 96
  - formula, 1, 447–448
  - infrared spectrum, 3, 213–214



**Carbon—*cont.*****tetrachloride—*cont.***

- infrared transmission, 8, 284
- liquid air on, 6, 211
- molecular structure, 1, 562–564
- reaction with aniline, 1, 408
- reduction, 1, 478
  - by hydrogen, 2, 143
- sound from, 3, 156
- spark spectrum, 3, 180–182, 204
- viscosity, 5, 142–154
- tube furnaces, 7, 239–240
- ultraviolet spectrum, 3, 260
- valency, 1, 549–554; 5, 562
- vessels, 5, 88
- X-ray transparency, 4, 487

**Carbonate ion,**

- infrared spectrum, 9, 227
- structure, 9, 81–86

**Carbonates, 1, 332**

- action of concentrated hydrochloric acid, 6, 95
- basic, 1, 332
- crystal structure, 8, 318, 321–325
- formulae, 2, 201

**Carbonisation, 9, 326****Carborundum,**

- conduction, 7, 240
- crystal structure, 8, 329–330
- decomposition, 8, 302
- effect of fused alkali, 7, 33
- in furnace, 7, 240
- iron reaction, 8, 303

**Carbonyl chloride, 7, 383****Carbonyls, 4, 205–217****Carboxylic group, 5, 529****Cardew voltmeter, 4, 333****Carmathus tinctorius, 2, 190****Carnations, 10, 120****Carnotite, 6, 52; 8, 122****Carnot's cycle, 1, 182–183**

- gas cycle, 6, 354
- principle, 5, 66; 6, 348–360
  - and caloric, 8, 349–350
- theorem, 1, 198–200

**Carotene, 6, 415; 9, 114; 10, 229–234**

- algae, in, 10; 235
- animals, in, 10, 235
- butter in, 10, 239–243
- chromatography, 10, 229, 231
- degree of unsaturation, 10, 229

**Carotene—*cont.***

- discovery, 10, 228
- food, in, 10, 235–243
- formula, 10, 228
- grass, in, 10, 228, 235, 239–243
- isomers, 10, 229
- milk, in, 10, 239
- occurrence, 10, 228
- optical rotation, 10, 229
- spectrum, 7, 368; 10, 232
- structure, 10, 232
- vitamin A, and, 8, 375–376; 10, 237–243

**Carotenoids, 10, 227–243**

- action of sulphuric acid, 10, 227–228
- bacteria, in, 10, 236
- biogenesis, 10, 236
- chromatography, 10, 230–231
- invertebrates, in, 10, 236
- physiological effects, 10, 237
- spectra, 10, 232

**Carrier waves, 10, 405–413****Carrots,**

- carotene in, 10, 227, 228
- colour, 6, 415; 7, 368

**Cartesian diver, 5, 12****Carthamine, 1, 487****Caryophylline, 6, 12****Cascade effect in lighting, 3, 101****Cascade of condensers, 3, 100–101****Cast-iron,**

- hysteresis, 8, 508
- melting point, 7, 237

**Castner process, 3, 498–500; 6, 272–273****Deville process, 3, 496–509****Castor, 1, 433–434****Cat, carotenoids in, 10, 235****Catalpa tree, 5, 375****Catalysis, 1, 18; 6, 37**

- acid-base, 6, 102
- adsorption, and, 8, 28–29
- combustion, of, 7, 405–430
  - formation of red phosphorous by iodine, 1, 57
- gas-phase reactions by metals, 2, 72
- hydrogen chloride oxidation, 2, 269–270
- mutarotation, 7, 383

**Catalysis—*cont.***

definition, 1, 158; 7, 100

nature, in, 1, 162–163

organic, 8, 27

theory, 1, 158–163

**Catalyst, heterogeneous, 8, 30****Cataract, 7, 50****Catechu brown, 3, 170****Caterpillar's foot, 4, 186****Cathode,**

calcium, 6, 243

concave, 4, 504; 5, 100–101

dark space, 9, 122

definition, 2, 73

Goldstein's double, 6, 320–322

heated, 7, 488

material, effect on X-rays, 5, 112

metal oxide, 6, 167; 7, 36–37

rays, 4, 490–493; 5, 36–49, 99–124, 405–416, 507, 551

absorption coefficients, 5, 47

air, in, 4, 497; 5, 46–48

bombardment of quicklime, 5, 101–102

collision cross-section, 5, 47–48

conversion of diamond to graphite, 5, 103

effect on alkali chlorides, 5, 37

etching of glass, 5, 100

focusing, 5, 99–100

formation of X-rays, 4, 503

history, 5, 36–37

ionisation by, 6, 327–344

mass-charge ratio, 5, 48–49

negative charge, 5, 41–46

photographic effects, 4, 497

pressure, 5, 105

properties, 4, 502

slow, 7, 487–491

spectrum, 5, 108–109

theory, 5, 103–104

wavelength, 9, 207–213, 358

size, effect on X-rays, 5, 111–112

sodium-potassium, 6, 243

tungsten, 7, 488

Wehnelt, 7, 36–37, 488

**Cation, 2, 73****Cattle,**

breeding, 2, 276

food for, 8, 376

**Caustic soda (*see sodium hydroxide*)**

Cavendish, measurement of G, 4, 352; 5, 298–299

Cavities in crystals, 4, 52

Celery, 6, 12

Celestial evolution, 8, 32

Celestial spectra, 8, 237

Celestine, 5, 22

**Cell,**

crystal, 9, 122–134

Daniel, 3, 91

electrochemical, 1, 200

electromotive force, 6, 360–361

evaporation from, 3, 92

heat evolution in, 1, 186

high-pressure, 3, 510

infrared, 1, 348–386

leaf, 5, 372

low temperature, at, 5, 465

photoelectric, 7, 82–83

reaction, 8, 31

selenium, 5, 52

silver chloride, 3, 91–120

source of voltage, 9, 405–408

standard, 5, 452

storage, 6 375

surface of living, 9, 109

thermodynamics, 6, 360–361

ultraviolet, 1, 429–430

unit, 7, 330

**Cello, 8, 211****Cellobiose, 9, 50, 57, 59**

model of, 9, 248

structural formula, 9, 57, 246

**Cellophane, 9, 67****Celluloid, 4, 42; 5, 259; 7, 195; 9, 248**

absorption of X-rays, 8, 52–54

colouring by radium, 6, 9

electron diffraction, 9, 208–210

films, 7, 490

infrared transmission, 8, 284

phosphorescence, 4, 377; 5, 464

**Cellulose,**

chemistry, 9, 246–249

crystal structure, 9, 245–260

crystallites, 9, 252–257

cupramine, 9, 259

derivatives, 9, 259

fibres, 9, 246

formula, 9, 50, 58–62, 246

membranes for filtration, 9, 67

occurrence, 9, 246

**Cellulose—*cont***

- structural formula, 9, 59
  - structure of mercerised, 9, 259
  - X-ray diffraction, 9, 245–260
- Centre of earth, 7, 55
- Centrifugal force, 5, 278
- Centrifuge for protein molecular weight, 10, 217

**Cephalopoda, 4, 240****Cerane, 2, 486****Certe, 1, 331, 3, 410****Cerium,**

- atomic heat, 7, 401
- refraction, 2, 541
- volume, 7, 401
- weight, 1, 500–509, 2, 541
- discovery, 2, 316–317
- silicate, 1, 331

**Cerotic acid, 1, 479**

- formula, 1, 546–547

**Ceryl alcohol, 1, 479, 546****Cespite, 1, 400****Cetane, 2, 486****Cetyl alcohol, 1, 479****Cetyl sulphonic acid, 9, 64****Ceylon,**

- graphite, 7, 27
- thoria, 6, 85–87
- thorianite, 8, 125, 134
- thorite, 8, 125, 134

**Chain,**

- conjugated, 10, 132
- polymer, 10, 257–269
- polypeptide, 10, 416
- reactions, 9, 218–219

**Chains of bubbles, 8, 142–152****Chalcolite, 6, 52****Chalcopyrite, 8, 495–509****Charles' law, 2, 343, 4, 105–106****Chalk, 7, 54**

- districts, water from, 2, 262–264

**Chamber,**

- cloud, 5, 466, 6, 61–66, 7, 312–324
- ionisation, 7, 449

**Characteristic  $\gamma$ -rays, 7, 505–506**

- X-rays, 7, 451, 505–506, 8, 58
- and atomic number, 8, 132

**Charcoal, 2, 384**

- adsorption by, 6, 104–119, 210–231
- analysis, 6, 406
- bacteria, action on, 7, 86–92

**Charcoal—*cont***

- boat, 4, 29
  - burnt by infrared, 1, 532
  - calorimeter, 6, 229–230
  - cane-sugar, 6, 107
  - cocoanut, 6, 105, 107
  - decolorisation by, 6, 104
  - densities, 6, 106
  - density of gases in, 6, 216–218
  - formula, 6, 231
  - gas mixtures, adsorption of, 6, 397–399
  - gases, adsorption of, 6, 693–404, 7, 66–67
  - heats of adsorption, 6, 108–111, 255
  - helium, adsorption of, 6, 384
  - hydrogen adsorption, 6, 254
  - hydrogen-oxygen reaction, 6, 395
  - insulation, 5, 164–166
  - isotherms, adsorption by, 6, 224–226
  - kinetics of adsorption, 6, 251–254
  - latent heats of adsorption, 6, 251–254
  - liquid oxygen, action of, 4, 463
  - low temperature adsorption, 6, 397–404
  - motion in water, 4, 29–31
  - nitrogen adsorption isotherm, 6, 254
  - nitric acid reaction, 6, 231
  - porosity, 6, 107–108
  - potassium permanganate reaction, 6, 231
  - occlusion pressures, 6, 254–255
  - oxygen, isolation of, 6, 111–113
  - preparation, 6, 214
  - production of solid hydrogen, 6, 389–390
  - reduction of metals, 1, 285–286
  - respirators, 2, 306–313, 6, 395
  - sewer covers, in, 6, 395
  - structure, 6, 406–417
  - thermometer, 6, 228–229
  - thermoscope, 8, 253–270
  - types of, 6, 395
  - vacua, 6, 106, 113, 215, 393–404, 417–421
  - water, for purifying, 6, 395
- Charge,**
- clay particles, on, 10, 292–295

**Charge—cont.**

- earth, on, 1, 341; 4, 172
- electron, on, 5, 553; 7, 178; 9, 205
- electronic, 5, 407
- Faraday, the, 2, 67–72
- hydrogen ions, on, 5, 407; 8, 115
- mass ratio, 7, 184–194
  - electrons, of, 5, 405
  - ions, of, 6, 233–247
  - kanalstrahlen, of, 6, 232
  - $\alpha$ -particles, of, 6, 284; 7, 503
  - positive rays, of, 6, 314–344
- measurement, 3, 92
- nuclear, 8, 131–133, 245
- unit, 3, 92; 5, 552

**Charged water-drops from fountain,**  
1, 171**Charging circuit, 3, 484**

- of condenser, 3, 95

**Chemical.**

- action and ionisation, 6, 95–96
- concentrated acids, of, 6, 95–96
- distance, at a, 1, 236
- light, of, 1, 202–204, 319–326  
(*see also photochemistry*)
- radium rays, of, 7, 101–102
- spark, in a, 1, 258–259, 278
- X-rays, of, 7, 101
- adsorption, 2, 43–44, 229–233
- affinity, 1, 18, 127–130, 136–139, 199, 236–237, 261, 373–380, 415, 539–568 (*see also chemical force*)
- electricity, and, 9, 107
- temperature, and, 5, 465
- analysis, 2, 140; 7, 184–194
- of coal, 1, 404–405
- combination,
  - conservation of mass, 5, 311
  - heat of, 4, 142
  - law of, 1, 74
- composition and refraction, 6, 153–166
- constitution, 2, 177–183
- isomorphism, and, 2, 500
- viscosity, and, 5, 135–154
- contact-force, 1, 18
- elements, 8, 113–135
- energy, 1, 199, 373–380
- equilibrium, 2, 422; 3, 544

**Chemical—cont.**

- force, 1, 4–8, 18, 136–139, 236, 373–380
- kinetics, 2, 132–135; 3, 544
- light, effects of, 1, 202–204, 319–326 (*see also photochemistry*)
- photometer, 1, 319–326
- polarity, 1, 111
- potential, 8, 29
- radiation detector, 4, 341
- rays, 1, 319–326, 427–434; 2, 13–22, 156–177 (*see also ultraviolet*)
- reaction and viscosity, 7, 196
- reactivity, 10, 384–403
- structure, 3, 177–183, 194
  - boiling point, and, 2, 182
  - colour, and, 2, 182
- substitution, 3, 546
- surface effects, 1, 160–161
- thermodynamics, 2, 422
- Chemiluminescence, 4, 507; 9, 217–222
- alkali metal-halogen reactions, of, 9, 220–221
- atomic hydrogen, and, 9, 221
- ether oxidation, of, 6, 300
- kinetics, and, 9, 217
- phosphorous, from, 1, 22 (*see also phosphorous and phosphorescence*)
- sodium-iodine, 10, 389–390
- solution, in, 9, 219
- Chemisorption, 2, 43–44, 229–235
- Chemistry,
  - analytical, 6, 101
  - classical mechanics, and, 3, 540–559
  - electric discharges, in, 3, 80–90
  - electrons, and, 8, 131
  - electricity, and, 4, 282
  - high temperature, at, 3, 80–90
  - high vacua, in, 6, 219–226
  - living organisms, in, 8, 26–31
  - mineral, 1, 90
  - sun, of, 1, 381–389
  - organic, 1, 90, 205
    - definition, 1, 141
  - plasma, 3, 80–90
  - radiation, 7, 101–102
  - sugars, of, 9, 48–62

- Cherry, 9, 115  
Chile saltpetre,  
  iodine in, 6, 181  
  production, 6, 181  
Chilled glass, 4, 187  
Chimneys, smoking, 2, 276  
China clay, 10, 288-290  
Chinese glass, 9, 158, 161-163  
Chinese white, 7, 213  
Chinoline,  
  coal, from, 1, 400  
  glass, 4, 263  
  infrared transmission, 8, 280, 288  
Chloracetic acid, 1, 155  
  dissociation, 7, 198  
  infrared transmission, 8, 257  
  synthesis, 1, 270-271  
Chloral hydrate,  
  action of alkali, 4, 119  
  density, 6, 6  
  expansion, 6, 6  
  infrared transmission, 8, 286  
Chloramine, 7, 196  
Chlorapatite, 5, 84  
Chlorate ion structure, 9, 81, 503  
Chlorates, reduction, 2, 499  
Chloric acid, 1, 328, 333  
  formula, 1, 484, 539-541  
  molecular structure, 1, 57  
Chloride ions, 6, 98  
Chloride of lime, 1, 410  
Chlorides,  
  acid, 1, 76  
  compared with fluorides, 5, 84  
  electrons, effect of, 5, 37  
  formulae, 2, 325  
  photoelectricity, 5, 37  
  thermoluminescence, 5, 37  
  viscosity, 5, 141-154  
  X-ray absorption, 4, 487  
Chlorine,  
  abundance, 10, 272  
  acetylene chemiluminescence, 9, 219  
  ammonia reaction, 9, 219  
  atomic heat, 7, 401  
  radius, 8, 326; 9, 501-502  
  refraction, 2, 138, 541  
  volume, 7, 337, 401  
  weight, 1, 507-508; 2, 541; 8,  
    129, 334, 340  
  azide, 7, 199  
Chlorine—*cont.*  
  bleaching action, 1, 155; 2, 266, 363  
  carbon, absorption on, 3, 543-544  
  carbon arc in, 3, 177  
  combustion of aluminium in, 3,  
    507  
  critical constants, 3, 315  
  density, 2, 154  
  dioxide, scattering of light, 4, 280  
    liquefaction, 9, 98  
    photocell, 7, 82-83  
    photolysis, 7, 80  
    ultraviolet spectrum, 3, 263-264  
  discovery, 2, 55, 265, 315-316  
  dissociation, 3, 126  
  electric discharge in, 2, 154  
  electronegative character, 1, 138  
  electronic structure, 8, 327  
  fluorides, action of, 5, 88-89  
  hydrate, 2, 55; 3, 21  
    composition, 9, 97  
    Faraday's work, 2, 55; 9, 97  
    hydrocarbons, action of, 2,  
      478-479  
  hydrogen,  
    actinometer, 1, 457-458  
    explosion, 1, 415  
    reaction, 7, 100  
    X-rays, effect of, 4, 502  
  infrared absorption, 1, 390  
  iodide, 1, 470  
  iodobenzene complex, 10, 345-346  
  ions, 5, 562; 7, 188  
    electronic structure, 8, 327  
    radius, 9, 86  
  isotopes, 8, 336-340; 10, 47-48  
  lichen, in, 10, 339  
  light,  
    effect of, 1, 261  
    emission, 5, 27  
    scattering, 9, 275  
  liquefaction, 2, 55-56; 3, 21-22;  
    4, 158; 9, 97-98  
  manufacture, 2, 265-270; 3, 500-  
    501  
  mass spectrum, 7, 188; 8, 336-337  
  moulds, in, 10, 339  
  nickel carbonyl, reaction with, 4,  
    209  
  non-integral atomic weight, 8, 129  
  nuclear fission, 9, 15-16

**Chlorine—*cont.***

- ozone, comparison with, 1, 23
  - phosphorous flame, 2, 154–155
  - photochemical reaction with hydrogen, 1, 320–326
  - photochemistry, 1, 202–204
  - ratio of specific heats, 5, 337
  - separation of isotopes, 8, 129–130
  - silicon, reaction with, 2, 385
  - silver fluoride, action of, 5, 88
  - sodium reaction, 7, 100
  - solid, 4, 461
  - solution, thinning of gold leaf by, 1, 216
  - ultraviolet,
    - absorption, 1, 430–431
    - spectrum, 3, 362–363
  - valency, 1, 549–554
  - water, reaction with, 2, 149
  - X-ray absorption of solid, 5, 160
  - X-ray scattering factor, 7, 452
- Chlorination of benzene, 9, 99**
- Chlorobenzene,**
  - film, 8, 1
  - infrared transmission, 8, 286
- Chloroethylamine, 7, 204**
- Chloroform, 2, 388; 4, 119**
  - ammonia, reaction with, 2, 197
  - charcoal, adsorption on, 6, 106
  - critical constants, 3, 315
  - formula, 1, 445–448; 2, 194, 197
  - hydrolysis, 7, 57
  - infrared,
    - absorption, 1, 493; 8, 285
    - spectrum, 3, 242–244
  - mass spectrum, 7, 187–191
  - molecular structure, 1, 512–514
  - mutarotation solvent, as, 7, 383
  - nitrogen, and active, 7, 309
  - silicon analogue, 2, 386–387
  - sound from radiation, 3, 152
  - synthesis, 1, 274
  - ultraviolet absorption, 1, 430–431
  - vapour, diffusion through rubber, 7, 471
  - viscosity, 5, 141–154
  - zinc-copper couple, action of, 2, 441
- Chlorohydrin, 8, 286**
- Chloronaphthalene, 8, 286**

- Chlorophyll, 1, 490–499; 5, 372; 9, 114; 10, 227–243**
  - fluorescence, 1, 490–491
  - optical properties, 1, 84–89
  - photosynthesis, in, 9, 193
  - spectrum, 1, 490–491; 3, 129; 4, 187
  - structure, 10, 237
- Chloropicrin, 9, 219**
- Chloroplasts, 9, 293**
- Chloroplatinate ion, structure, 9, 81**
- Chlorous acid, 1, 138, 328**
  - formula, 1, 454, 539–541
  - molecular structure, 1, 557
- Cholesterol,**
  - acetate, 7, 331
  - chloride, 7, 121
  - in fat, 8, 375
- Cholesteryl cinnamate, 9, 543–546**
  - transition points, 9, 543
- Chondrodite, 7, 130–133**
- Christiansen's experiment, 5, 253**
- Chromate ion structure, 9, 503**
- Chromate oxidation kinetics, 2, 134**
- Chromates, colour, 1, 301; 2, 182**
- Chromatic aberration, 1, 122**
- Chromatography,**
  - carotenoids, of, 10, 230–231
  - column, 10, 229
- Chromatised gelatin, 4, 42**
- Chromatope, 2, 57**
- Chrome alum,**
  - density, 6, 5–6
  - expansion, 6, 5–6
  - infrared transmission, 8, 284
  - paramagnetic cooling, 10, 93
  - seeding, 3, 399
  - specific heat, 6, 85–87
- Chrome colloidal, 1, 396; 2, 216–217**
- Chrome steel, 9, 214**
- Chromic acid, 1, 333**
  - colour and temperature, 4, 263, 378
  - ozonic character, 1, 282
- Chromic salts, colour, 2, 182**
- Chromium,**
  - abundance, 10, 272
  - acetate, 1, 221
    - spectrum, 1, 222
  - atomic heat, 7, 401
  - radius, 8, 326
  - refraction, 2, 541
  - volume, 7, 401

**Chromium—*cont.***atomic heat—*cont.*

weight, 1, 500–508; 2, 541

compounds, isomerism, 5, 195–196

discovery, 2, 316–317

electron diffraction, 9, 191

oxide, 1, 161

pigments, in, 9, 18

salts, spectra, 2, 433–434

steel, 9, 97

sun, in, 1, 358, 433

trace in explosion, 3, 446–450

ultraviolet spectrum, 3, 258, 264–265

**Chromophore,**

definition, 5, 529

quinoid character, 5, 529

**Chromoprotein, 10, 236****Chromosomes, 10, 429****Chromosphere, 8, 32; 9, 312****Chromous salts, colour, 2, 182****Chromyl chloride, 9, 219****Chronograph, 8, 357–359****Chronometer, 4, 359; 5, 451****Chrysene, 1, 399****Chrysin, 9, 116****Chrysogen, 5, 33****Chrysoidine, discovery, 3, 367**

R, 3, 368

Y, 3, 368

**Chrysolite, 1, 331****Chrysanthemum, 9, 115****Churchwarden pipe, 7, 240****Cigar, 1, 532****Cigarette paper, 4, 359****Cinchona plant, 2, 242; 6, 415****Cinchonine, 9, 198**

occurrence, 2, 242

**Cinnabar,**

allotropy, 1, 37

optical activity, 3, 516

**Cinnamic acid, 1, 76**

in indigo synthesis, 3, 166–167

synthesis, 3, 166

**Cinnamic aldehyde, 6, 12–13****Cinnamon, 5, 259****Circuits, resonant, 9, 433–440****Circular,**

pendulum, 1, 16

polarisation, 2, 271–272, 357–361

resonator, 4, 326

**Circulation, 10, 182****Citral, 6, 10, 12****Citric acid, 7, 359****Citronellal, 6, 10, 12****Citronellol, 6, 12****City air, 7, 461****Clark cell, 5, 452****Class O stars, 8, 371****Classes, symmetry, 7, 333****Classical mechanics and chemistry, 3, 540–559****Classification,**

elements of, 1, 500–508; 2, 326–329, 501; 3, 404, 418–420

organic compounds, of, 1, 574

**Claus structure, 6, 159–160****Clausius-Clapeyron equation, 6, 88; 7, 17****Clausius formula, 3, 316**

theory of electrolysis, 5, 486

**Clay, 7, 54; 10, 270–300**

charge on particles, 10, 292–295

china, 10, 298–299

effect of pH, 9, 320

hydrophillic, 10, 255

ion-exchange, 10, 298–330

plasticity, 10, 155

thixotropy, 10, 150–158

water, in, 10, 295–298

X-ray diffraction, 10, 286–300

**Cleavage and surface energy, 4, 120**

crystal, 1, 296; 4, 114

planes of bismuth, 9, 417

**Clevite, 9, 313**

helium, in, 5, 466

lead in, 8, 126

**Climate, effect of,**

atmospheric water, 3, 275–286

sun's radiation, 1, 319, 425–426

water masses, 2, 276

**Clinohemite, 7, 130–133****Clintonites, 10, 291****Clock,**

astronomical, 4, 359

microphone, 4, 100

Shortt, 10, 100

telegraphic, 4, 437

**Close packed,**

cubic, 7, 126

hexagonal, 7, 126

**Cloth particles in dust, 2, 302–303**

Clothing, warmth, 2, 275-281

Cloud.

chamber, 4, 111; 5, 406; 6, 63-66;  
7, 312-324; 9, 187-188

$\alpha$ -particles, and, 8, 521

cosmic rays in, 10, 35-38

neutrons in, 9, 416-418

formation, 6, 62-66

radium, by, 6, 64

X-rays, by, 6, 63-66

motion of, 4, 249

polarisation of light by, 2, 169

Clover flowers, 9, 116

Club, golf, 7, 104, 118-119

Clusters of bubbles, 8, 152-156

Coagulation of colloids, 6, 188-189

Coal,

analysis of distillation products, 1,  
398-407; 9, 326-331

anthracene content, 2, 242

chemical analysis, 1, 404-407; 3, 29

constitution, 1, 398-407

copper in, 8, 370

gas, 1, 37, 161

adsorption on charcoal, 6, 118-  
119

calorific value, 7, 413-417

combustion, catalysis, 7, 405-  
406

condensation, 5, 320

diffusion through rubber, 2,  
39-44

dye production, *u. c. in*, 1, 398-  
412

flame, 3, 180

spectrum, 3, 109-200, 205

ultraviolet light from, 1,  
427-428

vibrations, 4, 144

formula, 1, 154-155

heating power, 2, 276

hydrogen sulphide in, 2, 353

illuminating power, 2, 355

infrared absorption, 1, 306-307

production, 1, 306-307, 398; 9,  
326

separation of gases, 5, 157

sulphur in, 2, 353-356

ultraviolet,

absorption, 1, 430-431

spectrum, 3, 263

Coal—*cont.*

hydrogenation of, 9, 329-348

marcasite in, 2, 353

mine explosions, 3, 156; 4, 142-  
144; 6, 299

nature, 3, 362

oil from, 1, 34-41; 9, 325-356

paraffin from, 1, 34-41

petrol from, 9, 325-356

pyrites in, 2, 353

tar,

anthracene in, 2, 242; 9, 100  
antipyretic medicines from, 3,  
369-372

benzene in, 3, 363; 9, 100

coals, from different, 3, 362

constituents, 2, 241

drugs from, 3, 369-372

dyes, 3, 364-369; 9, 18-25, 100-  
101

history, 3, 360-376

industry, 3, 360-376

naphthalene in, 3, 363; 9, 100

oil, 1, 398

paraffins in, 3, 361-362

perfumes, 3, 372-376

production, 3, 361-362

products, fluorescence, 4, 507

saccharine, 3, 372-376

toluene in, 9, 100

Coaxial screening, 4, 97-98

Cobalt,

atomic heat, 5, 190-193; 7, 401

radius, 8, 326

refraction, 2, 541

volume, 7, 401

weight, 1, 500-508; 2, 325, 541;  
5, 190-195

bacteria, action on, 7, 86-92

blue glass, 1, 222

bromide,

anhydrous, 2, 428

hydrate, 2, 429

solution, 2, 428-434

carbonyl formation, attempts at,  
4, 214

carbonate, 9, 195

chloride,

anhydrous, 2, 428

colour change, 2, 425

hydrate, 2, 429



**Cobalt—cont.****chloride—cont.**

invisible ink, 2, 424–425

solution, 2, 425–434

discovery, 2, 315–316

glass, 1, 220–221

hysteresis, 8, 508

iodide,

anhydrous, 2, 428

hydrate, 2, 429

solution, 2, 428–434

isomerism of compounds, 5, 195–196

magnetism, 1, 1, 195

and stress, 3, 18–20

magneto-optic properties, 5, 175

magnetostriction, 10, 460–461

oxalate, 3, 445

oxide, 1, 161

catalysis of hydrogen chloride

oxidation, 2, 269–270

permeability, 4, 11

and temperature, 4, 140

peroxide, 1, 282

photographic plate, action on, 2, 257–258

pigment in, 9, 18

planes of force, 8, 506

position in periodic table, 7, 452

powder in magnetic field, 8, 489–509

production, 2, 125

reaction with carbon monoxide, 4, 208

salts, alcoholic, 1, 220

separation from nickel, 4, 214–215

specific heat, 2, 325; 5, 190–193

steel, 10, 158

sulphate,

dichroism, 4, 509

seeding, 3, 398

sun, in, 1, 359, 433

absence from, 1, 359, 433

trace in explosion, 3, 446–450

Villari effect, 3, 19–20; 4, 11

**Coccyges, 4, 237****Cochineal, 1, 221; 3, 365; 9, 101**

absorption spectrum, 1, 222

**Cocinic acid, 1, 546–547****Cocoanut charcoal, 6, 105, 107, 395; 7, 86–92****Cod oil, 9, 98****Cod-liver oil, 8, 375, 377****Codeine, 7, 355, 367****Coefficient,**

expansion, of, 4, 462–463

at low temperature, 6, 1–9

hysteresis, 8, 508

magnetostriction, 10, 460–461

mutual inductance, 4, 445

rigidity, 8, 350; 9, 167–168

sound reflection, 8, 369

viscosity, 5, 136–140

**Coercive force, 10, 459****Coffee,**

plant, 2, 242

photographic plate, action on, 5, 259

rubidium in, 2, 320

**Coherence,**

liquids, of, 8, 347

soap bubbles, of, 5, 233

**Coherer, 4, 336–339, 341; 5, 233–235**

demonstration, 5, 234

discovery, 4, 336; 5, 234

effect of various sources, 4, 342

mechanism of operation, 4, 337

metallic filing, 4, 336

resistance, 4, 339

short waves, for, 5, 14–17

screening, 4, 343–345

spiral spring, 5, 15–17

**Cohesion, 3, 326**

and aether, 6, 288

effect of temperature, 5, 472

nature, 8, 213

**Coil,**

Apps, 4, 489

focusing of electrons, 5, 99–100

induction, 1, 177–179, 315–316; 2,

546–549; 3, 94–95, 216,

489; 4, 169, 489

Apps, 4, 489

high-frequency, 4, 169

physiological effect, 4, 169

low-temperature resistance, 4, 518–519

regenerating, 4, 474; 5, 456

Rhumkorff, 4, 401

Tesla, 4, 169

**Coinage copper, 9, 214****Coincidences,**

Coincidences—*cont.*

- atomic spectra of, 3, 200–203
- Geiger-counter, 10, 32

## Coke,

- blast furnaces, for, 3, 361–362
- yields, 9, 336–340

## Cold working, 9, 2–3

## Collidine, 1, 400

Colliery (*see coal-mine*)

## Collimation of X-rays, 7, 343

## Collisions and spectral shifts, 3, 132

- atomic, 8, 244–252
- definition, 5, 333–334
- electric discharges, in, 6, 167–180
- electron-photon, 9, 5
- nuclear, 8, 536
- $\alpha$ -particle, 7, 316–318

## Collodion, 5, 260; 7, 490

- absorption of electrons, 5, 47
- diffusion of air through, 8, 3–4
- film, 8, 1–6
  - bursting, 8, 6
  - microscopic examination, 8, 4–6
- infrared transmission, 8, 273, 284
- iodised, 1, 259

## Colloidoscope, 9, 169

## Colloids, 9, 167–181; 10, 148–171

(*see also sols*)

- charges on, 6, 188
- coagulation, 6, 188–189
- conductivity, 9, 64–67
- definition, 2, 215
- dew-point, 9, 64–67
- dialysis, 1, 395–396
- diffusion,
  - in water, 1, 394–395
  - through rubber, 7, 484–485
- electrolysis, 6, 188–189
- freezing-point depression, 9, 64–67
- hydrophilic, 10, 155
- magnetic birefringence, 10, 165
- neutral, 9, 71
- osmosis, 9, 64–67
- preparation, 1, 396
- purification, 2, 216–217
- rigidity, 9, 167–181
  - coefficients, 9, 177
- separation from salts, 1, 395–396;  
2, 215–217
- starch, 9, 67
- strain birefringence, 9, 167

Colloids—*cont.*

- streaming birefringence, 10, 165–167

## structure, 10, 148–171

## theory, 9, 63–72

## turacin, 4, 238

## ultrafiltration, 9, 64–67

- vapour pressure, 2, 526–527; 9, 64–67

## viscosity, 9, 169

## Colloidal electrolytes, 9, 64–72

## gold, 1, 215–218, 249–251

## crystal structure, 8, 320

## effect of salts, 1, 217

## filtration, 1, 250

## iron hydroxide, 9, 194

## properties of dyes, 9, 72

## silver, 8, 320

## Colicis of lobster, 10, 236

## Cologne, 5, 259

## Colophonium, 7, 331

## Coloration of glass, 9, 164–165

## Colour, 9, 17–25

## blindness, 3, 430

## butter, of, 10, 239

## carbon compounds, of, 6, 414–417

## chemical structure, and, 2, 182

## complementary, 1, 243–245; 2, 405–410

## concentration, and, 1, 220–221

## conjugation, and, 9, 19

## cornflower, of, 9, 23–24

## design, 1, 244–245

## effects, 1, 219–226

## electric discharge, of, 3, 106

## extraction from flowers, 10, 112–114

## feathers, of, 10, 236

## flour, of, 7, 368

## flowers, of, 9, 114–121

## glass, of, 9, 155–166

## glazes, of, 9, 155–166

hydration of salts, and, 2, 424–434;  
9, 159

## inorganic, 9, 18

## insects, 9, 261–262

## ionisation, and, 6, 99–100

## iridescent, 9, 261–262

## laws of, 1, 241–245

## lapis lazuli, 9, 163–164

## light velocity, and, 3, 240

**Colour—*cont.***

- liquid films, 8, 1, 23–26
  - mixing, 3, 438
  - natural, 9, 18–25
  - Newton's table of, 3, 320
  - photography, 4, 479–484
    - discovery, 4, 479
    - interferential, 4, 480–484
    - theory, 5, 125–134
  - polarisation, 3, 516
  - polarised light, and, 2, 405–410
  - potassium chlorate, of, 7, 448
  - primary, 1, 241–245; 3, 438
  - quartz, from, 7, 379–380
  - range, visible, 3, 257
  - red rose, 9, 23
  - refractive index, change with, 1, 224–226
  - sap pH, and, 9, 115
  - saturated compounds, of, 9, 18–19
  - sea, of, 2, 254–264; 7, 93–99
  - sensitivity of photography, 4, 44
  - sky, of, 2, 171–177; 7, 93–99; 8 308–317
  - state of aggregation, and, 2, 1 6
  - studied by Rumford, 2, 275
  - sunlight, of, 3, 427–437
  - synthesis of natural, 10, 112–127
  - temperature and, 2, 424–434; 3, 378; 4, 261–263; 5, 464; 6, 428; 7, 238
  - tests for metals, 1, 354–355
  - theory, 1, 219–226, 241–245
  - thin plates, of, 3, 438–439
  - unsaturation and, 9, 18–19
  - vision, 4, 394; 5, 125–134
  - voltage of discharges, and, 3, 115–120
  - water, of, 2, 254–264
  - Young's work, 5, 278
- Coloured bands and fluid motion,** 4, 248–257
- Coloured rings in water,** 2, 513
- Coloured shadows,** 2, 275
- Columbite,** 7, 48
- Columns,** 6, 10
- chromatography, 10, 229
  - of bubbles, 8, 142–152, 162–173
  - extensibility, 8, 162–166
- Combination,** heat of, 4, 142

**Combination—*cont.***

- law of chemical, 1, 74, 127–130
- radius, 8, 381
- series, 8, 35–36
- tones, 4, 385–393; 10, 404–413
  - and non-linearity, 4, 386
- Combining proportions, 2, 542–545
- Combining volumes, 1, 549–554
- Combustion, 3, 377–393 (*see also flame*)
  - carbon monoxide, of, 8, 468–488
  - catalytic of ammonia, 1, 168
  - catalysis, 7, 405–430
  - electrons in, 7, 410
  - effect of cooling, 6, 310–311
  - explosive, 6, 299–313
  - flameless, 7, 408–409
  - hydrogen, of, 8, 468–488
  - hydroxylation in, 6, 303
  - infrared radiation, by, 1, 529–534
  - kinetics, 2, 132–133
  - liquid oxygen, in, 4, 463
  - mechanism, 6, 301–313
    - for carbon monoxide, 8, 473–475
  - preferential hydrogen, 6, 301–303
  - pressure,
    - high, at, 8, 462–488
    - low, at, 1, 360–364
  - surface, 7, 405–430
  - tantalum, at, 7, 51
  - theory, 1, 156–163; 6, 301–313
- Comets,** 1, 149
  - hydrocarbons in, 3, 179
  - motion, 4, 350
  - spectra, 3, 179
  - tails, 6, 150
- Common balance experiment,** 5, 301–303
- Common house electrometer,** 1, 337–338
- Common salt,** melting point, 7, 237
- Commutator,** 1, 28; 4, 91
- Compass,** 6, 372
  - compensation, 3, 19
  - effect of electrical system, 4, 97
  - optical, 4, 361–364
  - screening, 4, 96–97
- Compensator,**
  - Babinet's, 3, 12–13
  - quartz, 3, 529
- Complex formation,** 1, 128–129

- Complimentary colours, 2, 405-410;  
5, 419
- Composition and explosion, 9, 466-467  
chemical, 1, 127-130  
of rotary motion, 1, 120
- Compound vibrations, 8, 205
- Compounds of carbon, number, 9, 18
- Compressed crystals,  
optical activity, 4, 124  
oxygen, preparation, 4, 457
- Compressibility, 6, 98; 8, 346-362  
gases, of, 8, 347  
liquids, of, 7, 18; 9, 273  
measurement, 8, 348-349  
solids, of, 7, 18;  
temperature, and, 5, 143-146
- Compression by bullet, 8, 303-308  
air, of, 4, 3  
gases, demonstration, 4, 105  
surface film, 9, 110-111  
waves, 8, 292
- Compton effect, 9, 189-190, 201-204, 280-281, 379-380, 415
- Computer for tides, 6, 372
- Concave cathode, 4, 504; 5, 100-101  
surface, sound effects, 6, 60-61
- Concentrated acids, chemical action,  
6, 95-96
- Concentration and band intensity,  
5, 1-4  
colour, 1, 220-221  
infrared absorption, 1, 349  
light absorption, 7, 360-362
- Concentration surface, 9, 111-112
- Concentric half-bubbles, 8, 156-158
- Concords, 4, 384
- Condensation,  
calorimetry, 6, 74  
ions, by, 6, 62-66  
nebulae, of, 6, 151  
nuclei, 6, 62-66  
oxygen by magnetism, of, 1, 3  
polymerisation, 10, 268-269
- Condenser, 3, 94 (*see also capacitor and capacitance*)  
breakdown, 3, 95  
discharge, 7, 278-285  
effect on alternator, 4, 168  
energy of charging, 3, 95  
induction coil secondary, for, 3, 218
- Condenser—*cont.*  
microscope, 1, 122-126  
series, in, 3, 100-101  
sub-stage, 4, 184
- Conduction, electrical, 1, 96-106,  
164-172 (*see also resistance*)  
absolute zero, at, 4, 258-259, 529-530  
acids of, maximum, 5, 491  
air, of, 10, 28-29  
anisotropic, 5, 14-15  
charcoal vacua, of, 6, 417-421  
colloids, of, 9, 64-67  
copper, of, 4, 99  
crystals, of, 1, 297  
demonstration, 4, 288-290  
dilute gases, of, 1, 197  
dilution, and, 5, 492-493  
electrolytes, of, 5, 491-493; 9, 394-397  
Faraday's work, 2, 80-82  
flames, of, 1, 111-114, 264, 334-347; 7, 1-4  
effect of salt, 7, 3-4  
fused lead, of, 1, 30  
gas discharges, of, 4, 288-290  
gases, of, 6, 17-23  
and radioactivity, 5, 510-511  
laws, 4, 518  
liquid helium, in, 7, 234  
low temperature, at, 4, 229-231;  
9, 419-445  
magnetic field, in, 1, 11; 3, 216;  
4, 534-535  
measurement, 4, 519-521  
mercury vapour, of, 6, 21-23  
metals, of, 9, 419-445  
theory, 5, 411-412  
Nernst filaments, of, 7, 47  
salt solutions, of, 6, 93-95  
selenium, of, 2, 468-477  
soap jellies, of, 9, 71  
solutions, 9, 64-67  
solid potassium nitrate, of, 1, 166  
temperature, and, 2, 344, 351-352; 5, 320, 459-461  
theory, 5, 412  
theory, of, 6, 431-433  
thermal, 1, 78 (*see also insulation*)  
and vibration, 1, 109

- Conduction, electrical—*cont.*  
 thermal—*cont.*  
   kinetic theory of, 3, 132–133  
   of metals, 6, 213  
   varying magnetic field, in, 4, 99
- Conductivity,  
   equivalent, 5, 492–493  
   molecular, 5, 492–493; 6, 93–95, 98
- Conductors, 1, 111; 5, 589  
   discovery, 4, 517  
   economics, 6, 376  
   force on, 3, 216  
   lightning, 3, 485; 4, 322
- Cones and rods, 4, 339–340
- Configuration of carbon atom, 5, 195
- Congo red, 3, 369
- Conical horn, 5, 476
- Coniferil alcohol, 6, 13
- Coniferin, 6, 13
- Conjugation, 10, 132  
   and colour, 9, 19
- Conning tower, 4, 96
- Consecutive reactions, 7, 248–250
- Conservation of angular momentum,  
   6, 368–369  
   chemical force, 1, 236  
   energy, 4, 100; 6, 348–360  
     in nature, 1, 370–380  
   force, 1, 227–240  
     in nature, 1, 370–380  
   heat, 1, 235–236  
   mass, 5, 311  
   matter, 1, 236  
   zones, 1, 297
- Consonance, 4, 384
- Constant,  
   diffusivity, 5, 374  
   etherial, 8, 217  
   gravitational, 4, 350–374; 5, 296–303; 10, 101–103  
   Planck's, 7, 508–509  
   Rydberg, 8, 34–46
- Constellations, 1, 120
- Constitution,  
   chemical, 2, 177–183  
   molecular, 1, 5
- Contagion, 2, 30–35
- Continuous current, 8, 216
- Contours, shadows of film, 8, 158–159
- Contact and Newton's rings, 10, 204–208
- Contact and Newton's rings—*cont.*  
   angles, 3, 326, 332–349  
   electricity, 1, 180; 3, 327–356; 5, 50–83  
     demonstration, 5, 53–55  
     discovery, 5, 51–52  
     measurement, 5, 58–61, 80–83  
     platinum and oxygen absorption, of, 5, 56, 82–83  
     theory, 5, 563  
   force, 1, 18  
   optical, 2, 374–375; 10, 201–213  
     adhesion, and, 10, 203–204  
     dust, and, 3, 232  
     rolling, 3, 451–453
- Contraction and expansion,  
   bubbles, of, 8, 87–89  
   cotton by alkalis, of, 1, 340–341  
   earth, of, 8, 213  
   Fitzgerald-Lorentz, 8, 213  
   motion, 8, 213  
   sound from, 1, 107–110  
   transversal, 3, 60–62  
   velocity, 8, 182–184
- Contrast,  
   simultaneous, 1, 242–243  
   successive, 1, 242–243
- Control of rotation, 4, 433–436
- Convection loss, 4, 223–224
- Convex surface, attractive by jet, 7, 438
- Cookery, 2, 275–281
- Coolidge tube, 7, 488
- Cooling,  
   calorimetry, 6, 74–75  
   evaporation, by, 2, 402; 5, 361  
   expansion, by, 4, 457  
   flames, effect on, 6, 310–311  
   hydrogen, of, 4, 467  
   iron in magnetic field, of, 4, 141  
   magnet, effect on, 4, 270–272  
   paramagnetism, by, 10, 89–98  
   steel, of, 5, 447  
   thermionic emission, by, 7, 495
- Coordinates, Lagrangian, 5, 332
- Copaiba oil, 1, 37
- Copal varnish, 5, 258
- Copper,  
   absence from sun, 1, 359  
   abundance, 10, 272  
   action on bacteria, 7, 86–92

**Copper—*cont.***

alloys, 3, 507–508  
 aluminium alloy, hardness, 9, 2  
   resistance, 4, 525–527  
 aluminium couple, 2, 497  
 arc, 7, 83  
 atomic heat, 5, 190–194; 7, 401  
   and temperature, 8, 104–106  
   radius, 8, 326  
   refraction, 2, 138, 541  
   volume, 7, 401  
   weight, 1, 500–509; 2, 325, 541;  
     5, 190  
 bananas, in, 4, 237  
 Bath springs, in, 5, 159  
 belt metal, in, 9, 214  
 boiling point, 7, 237  
 borax beads, 9, 159  
 breaking stress, 4, 267  
 bronzes, in, 9, 214  
 carbonate, basic, 1, 332  
 chloride (*see also cupric and  
   cuprous chloride*)  
   from coal, 8, 370  
   heat of formation, 2, 149–150  
   osmosis, 2, 217  
 coal, in, 8, 370  
 coinage, 9, 214  
 cold-working, 9, 2–3  
 combustion catalysis, 7, 406  
 chromate, 1, 223  
 crystal structure, 9, 2, 215  
 diamagnetism, 1, 191  
 diffusion of zinc into, 10, 248–250  
 distilling, 2, 276  
 earth's centre, in, 7, 55  
 eddy currents, 3, 306–311  
 effect on mutual inductance, 3,  
   302–304  
 electrodes, 3, 107–108; 7, 403  
 electrolytic production, 1, 284  
 electron density, 5, 412  
 electron diffraction, 9, 191  
 electrons from, 7, 324  
 electropositivity, 5, 563  
 emissivity, 8, 290  
 equivalent weight, 5, 553  
 expansion, 4, 462  
 ferrocyanide, 7, 5  
 fluorine preparation, use in, 5, 96  
 foil, 9, 2

**Copper—*cont.***

formation of X-rays, 4, 504  
 glass, in, 9, 155–161  
 gun-metal, in, 9, 214  
 haemocyanin, in, 4, 240  
 heat of alloying,  
   aluminium, with, 5, 72–73  
   silver, with, 5, 71–73  
   zinc, with, 5, 71–73  
 Heusler's alloy, in, 8, 489  
 hydride, 1, 93  
 hydrogen silicate, 1, 331  
 mirror-metal, in, 9, 214  
 nature, in, 4, 240  
 pigments, in, 9, 18  
 speculum, in, 9, 214  
 turacin, in, 4, 235–240  
 iron thermocouple, 3, 22–23; 5,  
   64–65  
 lead thermocouple, 4, 538  
 low-temperature resistance, 4, 230  
 malleability, 9, 2  
 melting point, 5, 241; 7, 237  
 nitrate, 8, 1  
   basic, 2, 210  
   hydrate, 2, 210  
 nitrogen preparation using, 4,  
   397–398  
 occlusion of hydrogen, 2, 47  
 occurrence, 2, 125–126  
 oxide and active nitrogen, 7, 308  
   catalysis of hydrogen chloride  
     oxidation, 2, 269–270  
 film, 5, 56  
   on copper, 3, 238  
 glass, in, 9, 155–156  
 rate of discharge, 6, 21  
 oxychloride, 4, 46  
 palladium thermocouple, 4, 219  
 permanganate, 6, 100  
 plate, motion in magnetic field, 4,  
   74–77  
 platinum thermocouple, 4, 219  
 porphyrised, 4, 336  
 position in periodic table, 7, 452  
 production, 1, 285; 2, 125  
 prussiate colloidal solution, 1, 396  
 purification, 5, 194  
 rate of discharge, 6, 21  
 reaction with silver nitrate, 2,  
   335–337

**Copper—cont.**

reflection of Hertz waves, 4, 346

resistance, 3, 92

and temperature, 4, 522–535,  
459–461

rigidity, 8, 360

salts,

reaction with hypophosphorous  
acid, 1, 93

spectrum, 1, 484

screen, 4, 99–100

specific heat, 2, 325; 5, 190–194

resistance, 4, 99

spectrum, 1, 384

sucrate, 1, 396

sulphate (*see also cupric sulphate*)

ammoniacal, 1, 220

colour, 9, 159

crystal form, 4, 114

diffusion in gelatine, 5, 373–374

electrolysis, 5, 487; 6, 183–185

hydrate, 7, 299

reduction, 9, 156

superconductivity, 9, 424

thermal conductivity, 6, 213; 7,  
47

tin alloy, 9, 2

trace in explosion, 3, 445–450

transmission of radioactivity, 5, 508

tree, 2, 338

vacuum vessels, 6, 218

vibrations from, 1, 107–111

wire, 3, 561–562

X-ray absorption, 8, 50–54

X-ray fluorescence, 7, 324

Young's modulus, 8, 354–355

Zeeman effect, 6, 208

zinc,

contact electricity, 3, 233; 5, 50–  
83

couple, 2, 439–441, 497–499

Corals, 10, 336–337

Corchorus capsularis, 5, 23

Core,

laminated, 4, 412

losses, 4, 136, 512–513

Corn,

density, 3, 355

granular properties, 3, 352

Cornet, 8, 207

Cornflower,

blue, 10, 113

colour, 9, 23–24

cyanin in, 9, 115

pigment, 9, 114

pink, 10, 112–127

Cordite, 7, 274–279

Coridine, 1, 400

Cork,

action of fluorine, 5, 96

charcoal, 6, 106

Poisson's ratio, 8, 351

powder, 9, 298

Corona, 1, 440; 2, 254–255; 9, 323

spectrum, 5, 469–470

Coronium, 5, 470

Corpuscles, 5, 557

effect of ultrasonics, 9, 293–294

refraction of, 8, 511–512

Corpuscular proteins, 10, 429

radiation, 7, 446

theory of,

aether, 3, 350–351

light, 8, 510–515; 9, 4–5

X-rays, 9, 4–5

Corrosive sublimate, 1, 408

Corydaline, 7, 367

Corythacola, 4, 237

Cosmic,

disturbances, 4, 172

effects of electrons, 5, 414–416

evolution, 8, 32

hydrogen, 8, 40

rays, 9, 230–231; 10, 28–44

atmosphere, in upper, 10, 31

cloud chamber, in, 10, 35–38

energy, 9, 231; 10, 29, 35, 38–41

flux, 10, 32

geographical distribution, 10,

34, 38–41

initiation of discharge, 9, 123

lakes, in deep, 10, 31

origin, 10, 29, 33, 40–41

time and, 10, 33

wavelengths, 9, 224, 230

Cosmogony, 10, 34

Cotarnine, 7, 365

Cotterite, 4, 52

Cotton,

bleaching by chlorine, 2, 266

contraction by alkali, 1, 34–41

- Cotton—*cont.*  
   dyeing, 9, 22  
   fibres, 9, 246  
   flowers, 9, 116  
   mercerised, 1, 34–41  
     structure, 9, 259  
   water absorption, 2, 278  
   wool,  
     action of liquid oxygen, 4, 463  
     filter, 8, 311–312  
     heat insulation, 2, 271  
     phosphorescence, 4, 377; 5, 461  
   yellow colloid,  
     rigidity, 9, 177  
     streaming birefringence, 9, 177;  
       10, 165  
     viscosity, 9, 173–181  
 Coulomb, 5, 552  
   torsion balance, 1, 185; 4, 352  
 Coultte's viscometer, 9, 170  
 Coumarin, 2, 146–147  
   formula, 2, 147  
   synthesis, 2, 147  
 Counter, 4, 437  
   Geiger, 6, 285–286  
 Counting, radioactive, 7, 182  
 Coupled pendulums, 8, 200–205  
   vibrations, 8, 198–211  
 Cow,  
   carotene in, 10, 235  
   food for, 8, 376  
   milk, 10, 239  
 Cracking of hydrocarbons, 9, 350–352  
 Cranberry, 9, 115  
 Crater, lunar, 7, 216–217  
 Creatine, 4, 377  
 Creep of quartz fibres, 4, 368  
 Creosote, 9, 340  
 Crescent moon, 6, 123  
 Cresol, 1, 274, 400  
 Cretinism, 10, 341  
 Cricket ball, 7, 104  
 Crocein scarlet, 3, 368  
 Crookes,  
   dark space, 3, 40–54  
   electric radiometer, 4, 169; 6, 260  
   radiometer, 3, 136; 5, 105; 6, 151,  
     251–259  
     argon, in, 4, 407  
     explanation, 3, 40  
   Crookes—*cont.*  
     radiometer—*cont.*  
       for pressure measurement, 6,  
         417  
     tube, 4, 485–510  
       exhaustion, 4, 489–490  
       fluorescence, 4, 490  
   Croquet-ball, 6, 57  
   Cross-wind, 7, 117–118  
   Crossed axial plane dispersion, 5, 548  
   Crossed polars, soap solutions under,  
     9, 65–72  
   Croton tiglium, 1, 542  
   Crotonic acid, 1, 542  
   Crown glass,  
     dispersion, 3, 245–246  
     window, 7, 357  
 Critical,  
   angle, 1, 122  
   for sound, 9, 286–287  
   constants, 3, 315; 5, 202–204  
   calculated, 3, 316  
   opalescence, 2, 295–297; 9, 276  
   ether, of, 4, 108  
   hydrogen, of, 4, 466–467  
   point, 3, 24–27  
   Cagnard de la Tour's experi-  
     ments, 2, 294–295  
   discovery, 2, 294–301; 5, 362  
   ether, of, 4, 108  
   hydrogen, of, 4, 466–467  
   solid-liquid, 2, 301; 7, 26  
   surface tension, and, 4, 109  
   Villari, 3, 18–20; 4, 10  
   pressure, 3, 314–317  
   striations, 2, 295–297  
   temperature, 3, 312–317  
     and melting point, 5, 319  
   value, Villari, 3, 18–20; 4, 10  
   velocity of liquids, 3, 298–299  
   volume, 3, 314–317  
 Cryogenics, 5, 459 (*see also low*  
   *temperature*)  
 Cryolite, 3, 503–504  
 Cryophorous, 5, 314–316  
 Cryptidine, 1, 400  
 Cryptograms, 10, 235  
 Crypton (*see Krypton*)  
 Cryotile,  
   anisotropic conductivity, 5, 24–25  
   microwave dichroism, 5, 23



**Crystal,**

- absorption of light by, 1, 298-304
- acicular, 7, 331
- acoustic properties, 1, 295
- angles, 7, 333
- anisotropy, 7, 120
- atmosphere, in, 7, 327
- biaxial, 1, 298-304; 2, 357-361; 4, 124; 5, 541-542
- birefringent, 2, 272; 5, 544-550; 7, 239
- bismuth, of single, 9, 137-138
- cavities in, 4, 52
- cells, 7, 122-134
- cleavage, 1, 295; 4, 114
  - and surface energy, 4, 120
- conduction of electricity, 1, 297
- definition, 7, 330, 334
- dichroism, 3, 127
- dielectric constants, 10, 172-174
- discontinuities, 3, 493
- dislocations, 3, 493
- effect of polarised light, 1, 256
- elasticity, 9, 78
  - of anisotropic, 8, 349
- electric properties, 10, 142-147, 172-177
- electronic distribution, 8, 330-331
- elements, 7, 325
- facettes, 1, 294-304
- flakiness, 9, 42-47
- fluorescence, 1, 298-304
- form, 1, 4-5; 4, 114
  - effect of foreign substances, 4, 51-52
  - models of, 1, 290-292
  - of quartz, 3, 351
- fundamental angles, 7, 351
- geometry, 1, 290-292
- growth, 1, 303; 4, 507
- habit, 5, 540
- hardness, 1, 295; 8, 330
- heat of,
  - evaporation, 9, 79
  - formation, 9, 79
  - solution, 9, 79
- ionic, 8, 329-330
- iridescence, 3, 493-495
- liquid, 7, 121, 331; 9, 65-72, 511-550

**Crystal—cont.**

- magnet, 1, 193-195, 296; 9, 131-154
- magnetic properties, 1, 296; 10, 142-147
- magnetic susceptibilities, 10, 142-147
- metallic, 8, 330
- microscopy, 4, 50-57
- molecular, 8, 329-330
- molecules in, 1, 293-304
- monoclinic, 5, 541-542
- motion of atoms, in, 7, 454
- motion of molecules, 4, 114-115
- negative, 4, 123
- optical properties, 1, 293-304; 2, 357-361; 5, 541-550; 9, 547-550
  - activity of compressed, 4, 124
- packing, 4, 116-118
- polarisation of light by, 1, 298-304
- planes, 7, 343
- pyroelectric, 4, 124
- refractive indices, 5, 543-550
- rejuvenescence, 4, 50-57
- restrahlen, 9, 223
- rotation of methyl groups in, 9, 505-506
- seeding, 7, 237
- soap, 9, 66-72
- spacing and temperature, 7, 454
- strain, 4, 124
- structure, 1, 293-304; 4, 114-126; 5, 538-550; 7, 120-134, 445-454; 8, 318-331; 9, 1-3, 214-216, 245-260; 10, 210-226
- alloys, of, 9, 214-215
- biological molecules, of, 9, 446-464
- cold-working, and, 9, 2-3
- elements, 7, 128
- expansion, and, 8, 382
- hardness, and, 9, 2-3
- inorganic, 9, 77-87
- magnetism, and, 1, 193-195
- metals, of, 9, 2
- organic, 8, 378-385
- properties, 9, 462-463
- temperature, 9, 258
- surfaces, 4, 118-119

**Crystal—cont.**

- symmetry, 1, 293; 4, 122; 5, 539; 7, 122–134
- theory, 9, 79
- thermal expansion, 1, 297
- triaxial, 5, 541–550
- twinning, 3, 493
- types, 8, 329–330
- uniaxial, 1, 298–304
- velocity of light in, 5, 541–550
- zones, 4, 51–57
- Crystalline,**
  - micelles, 9, 67
  - quartz, 8, 273
- Crystallinity,**
  - pigments, of, 9, 114
  - steel, of, 5, 447
- Crystallisation,** 1, 252–255; 3, 394; 4, 50–57, 114–120
  - arborescent, 7, 327
  - metals, of, 2, 335–341
  - parallel, 7, 326–328
  - suspended, 3, 394–402
- Crystallites of cellulose,** 9, 252–257
- Crystallo-chemical analysis,** 7, 325
- Crystallogenesi,** 4, 50–57
- Crystallographic axes,** 1, 294–304
  - indices, 1, 294–304
- Crystallography,** 1, 290–292
  - and geology, 4, 50–57
- Crystallloid,** 9, 71
  - definition, 2, 215
- Crystalloluminescence,** 4, 507–508; 9, 222
- Crushing strength of diamond,** 8, 361
- Crust, earth's,** 7, 54
- Crustacea,** 4, 240
  - carotenoids in, 10, 236
- Cube,** 1, 290; 4, 118; 7, 335
  - body-centred, 7, 347
  - face-centred, 7, 338, 347
  - law of radiation, 4, 225–226
  - Leslie, 5, 393; 8, 253–290
  - simple, 7, 347
- Cubic,**
  - close-packed, 7, 126
  - crystals, 7, 351
  - elements, 7, 128
  - symmetry, 7, 330–333
- Cubo-octahedra,** 7, 335
- Cuckoos,** 4, 237
- Cuculidae,** 4, 237
- Culture medium,** 7, 84
- Cumberland,**
  - graphite, 6, 107
  - red quartz, 4, 52
- Cumaric aldehyde,** 6, 12
- Cumarin,** 6, 12
  - occurrence, 3, 372
  - synthesis, 3, 372
- Cumene dyes,** 3, 368
  - from coal, 1, 399
  - infrared transmission, 8, 285
- Cuminic acid,** 1, 76
- Cupramine cellulose,** 9, 259
  - complex, 1, 68–69
- Cupric (see also copper)**
  - bromide,
    - anhydrous, 2, 428
    - hydrate, 2, 429
    - solution, 2, 428–434
  - chloride,
    - anhydrous, 2, 428
    - colour, 9, 159
    - hydrate, 2, 429
    - solution, 2, 428–434
  - chromate, 1, 223
  - cyanide, 7, 59
  - nitrate (see *copper nitrate*)
  - oxide in glass, 9, 155–156
  - salts, colour, 2, 182
  - sulphate-water eutectic, 2, 522
- Cuprous (see also copper)**
  - acetate, 9, 157
  - acetylide, 2, 143
  - bromide, 9, 157
  - chloride, 9, 157
    - ammoniacal, 3, 81
    - light-sensitivity, 4, 46
  - fluoride, 9, 157
  - iodide, 9, 157
  - ion, radius, 9, 86
  - mercuric iodide, 7, 121
  - oxide,
    - glass, in, 9, 155–161
    - preparation, 9, 156
    - yellow form, 9, 156
  - salts,
    - colour, 2, 182
    - double-decomposition, 9, 157
  - sulphate, 9, 157
- Curd fibres of soap,** 66–72

- Curie point, 9, 444  
 Curie's law, 10, 85, 89  
 Curium, discovery, 10, 254-255  
 Current, 1, 228, 238; 4, 426  
   action, 5, 422  
   continous, 8, 226  
   earth, 1, 435-441  
   eddy, 1, 140; 3, 304  
   flames, in, 1, 113-114; 7, 2  
   high frequency, 7, 266-293  
   magnetisation, effect on, 4, 412-425  
   maximum in superconductor, 9, 426  
   oscillations in induction coil, 1, 177-179  
   saturation of gases, 6, 18  
   soap films, effect on, 9, 323  
   thermionic, 7, 495  
   velocity, 1, 99-105; 2, 437-438  
 Curvature of lines of force, 1, 59-63  
 Curve-tracer, 4, 423-425  
 Curves, vibration, 8, 204-211  
 Cuthbertson's electrometer, 1, 184  
 Cuticle, leaf, 5, 372-373  
 Cuts, effect on muscle, 5, 422  
 Cutting instruments, 9, 97  
 Cyanamide process, 6, 181  
 Cyanide process, 6, 181  
 Cyanides,  
   infrared transmission, 8, 288  
   organic, hydrolysis, 1, 480  
 Cyanidin,  
   chloride,  
     composition, 9, 115  
     formula, 9, 118  
     synthesis, 9, 118-119  
   derivatives, 9, 115  
   iodide, 9, 120  
 Cyanin, 9, 114-121  
   discovery, 10, 129  
   dyes, 10, 129-141  
   sensitised plates, 4, 242  
   spectra, 3, 129-130  
   structure, 10, 131-133  
 Cynanogen, 5, 86  
   critical constants, 3, 315  
   discharge in, 4, 287  
   flame,  
     light emission, 5, 35  
     spectrum, 3, 174-186  
     velocity, 4, 145-149  
   formation in electric arc, 2, 80-84  
 Cynanogen—*cont.*  
   infrared transmission, 8, 288  
   liquefaction, 9, 98  
   magnetism, 1, 68  
   moist, flame, 3, 199-200  
   nitric oxide flame, 3, 180  
   nitrogen, from active, 7, 309-310  
   radical, 4, 205-207  
   silicon analogues, 2, 391-392  
   ultraviolet spectrum, 3, 260, 264-265  
   viscosity, 2, 219-221  
 Cyanophyceae, 10, 235  
 Cyanosine, 3, 368  
 Cyanotype, 4, 42  
 Cycle, Carnot, 6, 354  
 Cyclic magnetisation, 4, 135  
 Cyclic stress, 10, 225-226  
 Cyclides, Dupin's, 9, 517-536  
 Cyclohexane,  
   refraction, 6, 157, 161-162  
   spectrum, 7, 363  
 Cyclohexanol, 8, 285  
 Cyclohexanone, 8, 285  
 Cycloparaffins, 6, 408-409  
 Cyclopentane, 6, 408-409  
 Cyclopropane, 9, 503-504  
 Cyclotron, 10, 252  
 Cymene, 1, 399  
 Cymometer, 8, 201  
 Cystine, 9, 458  
   X-ray diffraction, 9, 251-253

## D

- D.C.,  
   electrical supply, 4, 97, 136  
   magnet, 8, 489-490  
 Daguerrotype process, 4, 39  
 Dahlia, 10, 112-127  
   cyanin in, 9, 115  
 Dalton,  
   atomic theory, 6, 24  
   and isotopes, 8, 332  
   law of,  
     multiple proportions, 6, 90  
     partial pressures, 2, 221  
 Damping and tuning, 4, 325-326  
   electrical oscillations, of, 3, 484  
   magnetic field, in, 4, 74-77

**Damping and tuning—*cont.***

- oscillations in tin, of, 8, 358
- radiation, 3, 485; 4, 325–326
- vibrations, of, 4, 388

**Dandelion, 10, 234****Daniel cell, 3, 91**

- heat form, 4, 3

**Dark field,**

- illumination, 6, 123

**space,**

- cathode, 9, 122
- Crookes', 3, 40–59
- Faraday, 9, 123

**Datura stramonium, 1, 88****Davy,**

- combustion and explosion, work on, 6, 299–300

**definition of flame, 6, 299**

- discovery of alkali metals, 6, 262–274

**electrochemical theory, 1, 136–139****electrochemical work, 6, 264–265****Faraday's view of, 9, 95****French medal, 6, 265–266****life, 6, 263–265****nitrous oxide, work on, 6, 263****relationship with Faraday, 2, 51–53****R.I., and, 6, 263****safety lamp, 6, 299****study of heat and work, 4, 2****Deal, 5, 259****Death, effect on muscle, 5, 418****De Broglie wavelength, 9, 207–213, 358****De la Rive and Faraday, 2, 52–54****De Meriten's dynamo, 3, 216–217****Debye equation, 8, 105–106****Debye-Huckel theory, 9, 410****Decane,**

- coal, from, 1, 399
- infrared transmission, 8, 285, 289
- preparation of pure, 2, 498

**Decay, first-order, 7, 248****Decaying organic matter, luminescence, 4, 375****Decaying wood, luminescence, 4, 507; 9, 218****Declination magnetic, 1, 73****Decolorisation by charcoal, 6, 104****Decomposition,**

- chemical, 1, 127–130

**Decomposition—*cont.***

- double-, 1, 20–21, 127; 2, 179
- gases in electric discharges, of, 1, 473

**by heat, 2, 149****nitrogen iodide, of, 1, 135****silver cyanide, of, 1, 56****Deep mineshafts, 8, 293****Deep-sea thermometers, 8, 348****Defect, mass, 8, 129, 341****Deficiency of vitamin A, 10, 237****Definite proportions, 1, 18****Deflection of loaded structures, 8, 361****Deflection rays by magnet, 4, 502****Deformation, plastic, 8, 292****Degree of ionisation, 5, 486–487, 495****Degree of polarisation, 8, 312–313****Degrees of freedom, 5, 332****Dehydration of ethyl alcohol, 2, 209****Dellman's electrometer, 5, 57****Delphinidin, 9, 23–24****chloride,****formula, 9, 119****composition, 9, 115****Delphinin, 9, 115****Delphinium, 9, 115****consolidation, 9, 115–116****Dimethylamine, 2, 186****Demon, Maxwell's sorting, 3, 36–37****Demonstration electric motors, 4, 82–86****adiabatic expansion, 6, 383****air liquefaction, 4, 232****ammonium chloride vaporisation, 6, 91****bearing friction, 3, 452****birefringence, 5, 544****Boyle's law, 4, 105****coherer, 5, 234****conductivity, 4, 288–290****and dilution, 5, 492–493****consecutive reactions, 7, 248–250****contact electricity, 5, 53–55****difference between fluorescence and phosphorescence, 4, 508****diffusion, 5, 373–374****electrical images, 4, 94****electrical stress in liquids, 3, 478–480****electromagnetic,****induction, 4, 72–74**

**Demonstration electric motors—*cont.***

- electromagnetic—*cont.*
    - radiation, 4, 18–25
    - waves, 4, 324–325
  - gas compression, 4, 105
  - gravity, 3, 568–569
  - half-lives, 6, 276–277
  - heat of alloying, 5, 72–73
  - heat transmission through liquid air, 4, 233
  - hysteresis, 4, 511
    - loss, 4, 514–515
  - inductance, 4, 77–79
  - induction, 4, 152–153
  - intermolecular forces, 3, 328–330
  - light polarisation, 3, 518–522
  - liquefaction apparatus, 3, 312–313
  - liquid air magnetism, 4, 221
  - low temperature phosphorescence, 4, 376–377
  - magnetic screening, 4, 101–103
  - magnetisation, 4, 130–136
  - model for waves, 3, 230–231
  - motion in magnetic field, 4, 74–77
  - multiple sound reflection, 3, 494
  - optical rotation, 6, 31
  - oscillator, 5, 12–13
  - oxygen,
    - liquefaction, 4, 218
    - magnetism, 4, 220–221
  - polariscope, 4, 187
  - p, V, T, data for water, 4, 106–109
  - piezoelectric effect, 9, 283
  - projection microscope, 4, 186
  - reaction surface, 10, 396, 402–403
  - resolution and aperture, 4, 69
  - resonance, 4, 387–393
  - shadow bright spot, 6, 55
  - silver chloride decomposition, 4, 43
  - sound diffraction, 3, 462–463
  - superconductivity, 10, 74–75
  - surface tension, 3, 333–337; 4, 27–28
    - and temperature, 3, 348; 10, 5
  - vibrations, 9, 297–211
  - viscosity, 3, 294
  - voltaic cell, 5, 53–55
  - wave motion, 5, 11–12
  - X-rays, 4, 486
- Denaturation, 10, 219–220, 414–415, 429–430**
- Dense flint glass, 9, 161**

**Density,**

- argon, of, 4, 401–408
  - fluctuations, 9, 273–276
  - gases in charcoal, of, 6, 216–218
    - measurement, 4, 397
  - gradients in diffusion 5, 383
  - infrared absorption, 1, 349
    - refractive index, 2, 137
  - iron, of, 3, 355
  - maximum for water, 4, 4
  - mean of earth, 4, 353, 373; 5, 300–303
  - measurement at low temperature, 6, 1–9
  - reticular, 7, 346, 351
  - salts, of, 5, 541
  - solids, of, 6, 6
  - superior limit, 5, 322
  - vacuum globe, 4, 473
- Dental instruments, tantalum, 7, 50**
- Depression of freezing point, 2, 523; 5, 494; 6, 97**
- colloids, of, 9, 64–67
  - soap solutions, of, 9, 64–67
  - theory, 7, 8
- Depth and oxygen occurrence, 7, 54–55**
- of focus, 4, 185
- Desiccants, 2, 401**
- Design and colour, 1, 244–245**
- dynamoes, of, 6, 376
  - ships, of, 2, 292–293
- Disintegration theory, 6, 275–286**
- Destructive distillation, 9 98**
- of wood and coal, 3, 29
- Detection of earthquakes, 4, 390**
- electromagnetic radiation, 4, 332, 341
  - infrared, 1, 305–308; 9, 223
    - by photography, 3, 207
    - quenching of phosphorescence, by 9, 223
  - poisons, 7, 368
  - soft X-rays, 7, 489
  - X-rays, 7, 449
- Dectector,**
- photoelectric, 4, 336
  - portable, 4, 343
- Detergent action, 9, 64**
- Determination of atomic weights, 8, 128–130**

- Detonation, 7, 409; 9, 469-474  
   acetylene, of, 9, 491-494  
   box, 9, 471-472  
   carbon monoxide-oxygen, 6, 301  
   definition, 6, 300  
   discovery, 6, 300-301  
   duration of luminosity, 6, 310  
   flames, of, 4, 143-144  
   spin in, 9, 481-493  
 Deuterium, 10, 15-27  
   atomic weight, 10, 21  
   atoms, 10, 392-397  
   Balmer series, 10, 17-18  
   bombardment by deuterons, 10, 25-26, 109  
   bromide, 10, 57-60  
   chloride, 10, 57-60  
   discovery, 10, 16-18  
   exchange reactions, 10, 19, 60-66  
   fluoride, 10, 58-60  
   iodide, 10, 57-60  
   isolation, 10, 18, 49  
   isotope effect, 10, 19, 60-70  
   nuclear disintegration, 10, 109  
     structure, 10, 21, 47  
   oxide, 10, 16, 47-70  
     boiling point, 10, 16  
     biological effects, 10, 20  
     chemical properties, 10, 47-70  
     density, 10, 16, 47  
     dielectric constant, 10, 16  
     enrichment, 10, 18, 49  
     germination in, 10, 20  
     latent heat of vaporisation, 10, 16  
     melting point, 10, 16  
     surface tension, 10, 16  
     vapour pressure, 10, 16  
     viscosity, 10, 16  
     zero-point energy of compounds, 10, 55  
   proportion in nature, 10, 15-27, 49  
   separation by diffusion, 10, 20-21  
   spectrum, 19, 17-18  
   substitution, 10, 63-64  
 Deuteron, 10, 30, 109  
   bombardment, 10, 25-26, 109  
 Developer, 4, 480  
   ferrous oxalate, 4, 48  
 Deville-Castner process, 3, 496-509  
 Dew,  
   point,  
   Dew—*cont.*  
     point—*cont.*  
       colloids, of, 9, 64-67  
       soap solutions, of, 9, 64-67  
       vibrations, 3, 331  
       theory of, 3, 269-270  
   Dewar vessels, 4, 223-229, 458-460, 521; 5, 364-365; 6, 385-401  
   design, 5, 161-166  
   deterioration, 4, 260  
   discovery, 8, 455  
   metallic, 6, 218, 404-405; 7, 64-66  
   silvering, 4, 225; 5, 166  
 Dextrin, 9, 59, 71  
   formula, 9, 246  
 Dextrose, 7, 14  
 Diabetes mellitis, 3, 375-376  
 Diacetyl, 9, 19  
 Diagrams, 4, 183  
 Diallyl,  
   infrared transmission, 8, 285  
   refraction, 6, 159  
   viscosity, 5, 141-154  
   zinc 2, 440  
 Dialysis, 1, 393-396  
   colloids, of, 1, 395-396  
   Graham's work, 2, 215-217  
 Diamagnetic elements, 3, 419  
   repulsion, 8, 506-507  
 Diamagnetism, 1, 64-73, 80, 188-195, 523-528; 9, 89, 131-154  
   alcohol, 1, 68  
   ammonia, 1, 68  
   antimony, 1, 191  
   arsenic chloride, 1, 68  
   bismuth, 1, 68-70, 145, 150-153, 189-195  
   calcium carbonate, 1, 80, 192-195  
   carbon disulphide, 1, 68  
   camphine, 1, 68  
   camphor, 1, 68  
   copper, 1, 191  
   crystals, 1, 296  
   cyanogen, 1, 68  
   definition, 2, 88-93  
   discovery, 1, 83; 2, 88-93  
   ether, 1, 68  
   Faraday's work, 4, 184  
   fused lead borate, 1, 68  
   gases, 4, 220  
   glass, 1, 67-73, 192

**Diamagnetism—*cont.***

- heavy glass, 9, 132–133
- hydrogen, 1, 68
- Iceland spar, 1, 80, 192–195
- linseed oil, 1, 68
- marble, 1, 192
- nickel carbonyl, 4, 210
- nitric acid, 1, 68,
- oil of lemons, 1, 68
- olive oil, 1, 68
- phosphorous, 1, 68, 145, 192
- potassium nitrate, 1, 192
- sulphur, 1, 68, 192
- sulphuric acid, 1, 68
- thallium, 1, 444
- temperature, effect of, 1, 195
- test for, 1, 66
- tourmaline, 1, 193–195
- water, 1, 67–69
- wax, 1, 68
- zinc, 1, 68
- theory, 140–153

**Diameter and torsion, 3, 561**

- electron orbits, of, 8, 59
- law, 3, 379–390
- stars, of, 8, 519

**Diamond, 1, 290, 384**

- artificial, 4, 487
- atomic refraction, 2, 137–138; 6, 156–162
- black, 7, 34
- bond angle, 9, 509
- bond strength, 9, 509
- Brewster's angle, 2, 170
- burning, 9, 94–96
- C–C distance, 9, 463–464, 509
- combustion in liquid oxygen, 4, 463
- conduction, 9, 399
- conversion to graphite, 5, 103; 8, 294
- crushing strength, 8, 361
- crystal structure, 7, 453; 8, 318, 329–330, 361, 380, 383; 9, 509
- electrical properties, 1, 256
- expansion, 8, 382; 9, 255
- graphite, from, 7, 28–35
- hardness, 8, 361, 382
- heat of combustion, 9, 464
- molten alkali, effect of, 7, 33
- non-conductor, 5, 559
- optical properties, 1, 256
- phosphor, 3, 50–51

**Diamond — *cont.***

- phosphorescent, 4, 508
- radioluminescence, 6, 41
- sparkle, 5, 538
- specific heat, 7, 233–234
- and temperature, 6, 83–85
- structure, 6, 160–161
- thermal expansion, 8, 382; 9, 255
- triboluminescence, 4, 507
- ultraviolet absorption, 1, 430–431
- X-ray,
  - diffraction, 7, 453
  - transparency, 4, 487

**Diamyl,**

- amyl oxalate, 1, 521
- mercury, 1, 518–522
- zinc, 1, 518–522
- synthesis, 2, 440, 498

**Dianilide, 10, 138****Dianthus, 4, 377****Diaphragm heating, 7, 411–414****Diaryliodol compounds, 10, 351–354****Diary larsenic acids, 10, 353****Diarylphosphinic acids, 10, 353****Diaspore, 1, 536****Diatomaceae, 1, 123****Diatomic gases, 5, 336–338****Diatomic molecules, 8, 104****Diathermanity, 1, 43****Diazo compounds, 7, 200–201****Diazoaminobenzene, 7, 203****Diazonium salts, 7, 199–204****discovery, 7, 199–204****Dibasic acids, 5, 497–498****Dibenzanthracene, 9, 509****Dibenzoylimide, 1, 157****Dibromoanthraknone, 2, 191****Dibromoanthraquinone, 2, 244, 245****Dibromocampnor, 8, 288****Dibromoindigo, 10, 339****Dibromosuccinic acid, 2, 145****Dibromotyrosine, 10, 339****Dicarbocyanins, 10, 132****Dichloroacetic acid, 8, 287****Dichlorobenzene, 8, 286****Dichlorofluorescein, 6, 99****Dichlorohydrin, 8, 286****Dichloropyridine, 8, 286****Dichroism, 1, 220–221****microwave, 5, 23–24****of crystals, 3, 127**

- Dickite**, 10, 289–290  
 X-ray diffraction, 10, 290
- Dicyanine**, 10 135
- Didymium**,  
 acetate, 2, 541  
 atomic refraction, 2, 541  
 atomic weight, 1, 541  
 chloride, 3, 129  
 discovery, 2, 72–82  
 nitrate, 2, 427  
 separation, 2, 415  
 sulphate, 3, 129
- Dielectric**,  
 breakdown, 3, 98–104  
 constant and frequency, 9, 429–430  
   crystals, of, 10, 172  
   discovery, 2, 72–82  
   fluctuations, 9, 273  
   liquefied gases, of, 5, 462  
   low temperatures, of, 6, 419  
   temperature, 5, 462  
   vacuum, of, 6, 419  
   water, of, 6, 419  
 properties of sulphur, 1, 266–269
- Dielectrics**, 1, 267 269  
 expansion in an electric field, 3, 480
- Diesel oil**, 9, 340, 348
- Diethyl**,  
 adigate, 8, 344  
 ether, 1, 161 (*see also ether*)  
   absorption by palladium, 2, 47  
   action of fluorine, 5, 96  
   adsorption of charcoal, 6, 106  
   formula, 1, 451  
   infrared transmission, 8, 286  
   molecular structure, 1, 403  
 hydrogen phosphate, 1, 332  
 ketone, 5, 142–154  
 mercury, 1, 518–522  
   formula, 1, 536  
 oxalate, 1, 519  
   infrared transmission, 8, 287  
 succinate, 8, 344  
 sulphate, 1, 329, 332  
 sulphide, 5, 141–154  
 zinc, 1, 536  
   synthesis, 2, 146  
   synthetic use, 1, 518–522; 2, 439–440, 498
- Diethylamine**, 1, 208  
 critical constants, 3, 315
- Diethylamine—*cont.***  
 formula, 1, 449–451  
 molecular structure, 1, 403
- Diethylaniline**, 8, 287
- Diethylphenylamine**, 1, 449
- Diethyltetraiodofluorescein**, 6, 99
- Difference tone**, 4, 385–393
- Diffraction grating**, 3, 143, 247, 441  
 electrons, of, 9, 190–192, 204–213, 357–364  
   gases, by, 9, 361  
   surfaces, by, 10, 244–251
- Hertz waves**, for, 4, 347
- light**, of, 3, 454
- sound**, of, 3, 454–465; 7, 448
- X-rays**, of, 7, 340 354, 445 454; 9, 1–3, 214 216, 245–260; 10, 210 226  
   alloys, by, 9, 214–215  
   intensity of, 7, 452–453  
   powder method, 8, 318–320
- Diffuse series**, 8, 35–36, 239
- Diffused resonance**, 8, 206
- Diffusion**, 5, 372–391  
 absolute velocity, 5, 374  
 adsorption, and, 2, 42–44  
 alum in water, of, 1, 394  
 apertures, through, 5, 379–390  
 argon, of, 4, 409–410  
 carbon dioxide through leaves, of, 5, 373–374  
 colloids, of, 1, 394–395  
 copper sulphate in gelatine, of, 5, 373–374  
 demonstration, 5, 373–374  
 density gradient, 5, 383  
 diameter law, 5, 375–390  
 electron stream, of, 8, 180  
 fractionation, 10, 68–69  
 gases, of, 2, 38–44, 221–233, 398; 3, 256; 7, 167  
   through black films, 8, 173–176  
   through bubbles, 8, 78–87, 166–173  
 gelatine, in, 1, 395  
 gels, in, 2, 215–217  
 Graham's law, 5, 374  
 ionic, 6, 100  
 ion stream, 8, 180  
 liquids, in, 2, 213–215; 7, 167  
 metals, in, 7, 465–469; 10, 248–250  
 nature, of, 1, 395



**Diffusion—cont.**

- pump, 9, 241–244
  - mercury, 4, 226–227; 7, 388
- rubber, through, 7, 470–486
- salts in water, of, 1, 393–396
- separation of,
  - gases by, 2, 228
  - isotopes by, 10, 20–21, 68–69
  - oxygen isotopes by, 10, 68–69
  - salts by, 1, 394
- soap bubbles, through, 8, 66–99
- solution, and, 2, 42–44
- temperature, and, 7, 476–479
- theory, 2, 38–44
- water vapour in flames, 5, 198–199

**Diffusivity constant, 5, 374****Digluco-side, pelargonidin, 10, 116****Dihydroxyanthraquinone, 3, 172****Dihydrate, 2, 504****Diiodotyrosine, 10, 337–340****Diisopropyl zinc, 2, 414, 498****Dilation of liquids, 8, 347****Dilutancy, 3, 350–359**

- of sand, 10, 154–155

**Dilute solutions,**

- osmosis, of, 7, 6
- soap, of, 9, 64

**Dilution and conductivity, 5, 492–493****Dimensions of nuclei, 9, 8–10****Dimensions of  $\alpha$ -particles, 9, 8–10****Dimethyl,**

- ethyl carbinol, 5, 142–154
- glucose, 9, 53–55
  - preparation, 9, 55
- ketone, 5, 142–154
- mercury, 1, 518–522
- oxalate, 8, 287
- oxalic acid, 1, 520
- rosaniline, 2, 188
- sulphide from sugar beet, 3, 31
- viscosity, 5, 141–154
- zinc, 1, 518–522

**Dimethylamine, 3, 29–30****Dimethylaniline, 3, 34–35****Dimethylbutadiene, 8, 285****Dimorphism, 1, 4**

- garnet of, 1, 36
- specific heat, and, 5, 192
- sulphur, of, 1, 36–37

**Diniodamide, 1, 448****Dinitronaphthol, 3, 368****Diolefines, 6, 158–162****Dioptase, 1, 331****Dip, 1, 10, 73; 4, 7****Dipentene,**

- nitrosate, 7, 202
- nitroschloride, 7, 202

**Diphenyl, 4, 377****Diphenylamine,**

- blue, 3, 368
- formula, 2, 186
- orange, 3, 368

**Diphenylbenzene, 10, 146****Diphenyliodonium iodate, 10, 353****Diphenylrosaniline, 2, 187****Diphtheria, 10, 416****Diplogen, 10, 20****Dipropargyl, 8, 285****Dipropyl,**

- ether, 5, 143–154
- zinc, 2, 440, 498

**Dirt and foam, 4, 36**

- effect on gas evolution, 6, 16

**Disaccharides, 9, 50, 57–58**

- hydrolysis, 9, 50–54

**Disc,**

- antinodal, 9, 309
- arc, 6, 151–152
- electrometer, 4, 98
- motion in water, 2, 513–517
- rotating in magnetic field, 4, 430–444

**Discharge,**

- electrical, 1, 31, 111–114; 2, 546–549; 5, 500–507 (*see also arc*)
- acetylene-nitrogen mixtures, in, 2, 198
- apparatus, 3, 204
- argon isolation, for, 4, 339–404
- brush, 4, 173–174
  - effect of X-rays, 4, 503
- carbon tetrachloride, in, 3, 180–182
- chemical action, 1, 258–259; 3, 80–90
- chlorine, in, 2, 154
- clearing of fog, 5, 234
- colour and pressure, 3, 106
- Doppler effect in, 9, 126
- electrode shape, effect of, 3, 99–101, 106
- energy loss in, 4, 185

**Discharge—cont.****electrical—cont.**

- flames, between, 7, 1-2
- fluorspar, effect on, 4, 508-509
- form of, 3, 219-320
- formation of acetylene in, 1, 143
- gases, in, 1, 473; 3, 176-179; 4, 282-290
  - conductivity, 4, 228-189
  - high-current, 3, 217-219
  - high-frequency, 4, 174-176
- high voltage, 3, 91-120
- hydrogen, in, 2, 154
  - chloride, 3, 181
  - cyanide, 2, 198
- inert gases, in, 5, 468; 7, 402-404
  - 9, 122-130
- initiation by cosmic rays, 9, 123
- ions in vacuum tube, of, 4, 284-285
- length, 3, 98-99, 107-108
- Leyden jar, of, 3, 481-495; 7, 278-288
- low pressures, at, 1, 277-281, 316-318
- magnesium electrode, between, 3, 186-199
- magnetic field, effect of, 1, 314-318; 3, 54; 4, 290; 5, 38-39
- mechanism, 3, 222-223
- mercury, in, 2, 154
- metallic dust in, 4, 284
- methane, in, 2, 356
- moist gases, in, 3, 199-200
- musical, 5, 500-507
- obstacles in, 4, 283-284
- oxygen, in, 2, 154
- passage down tube, 4, 283
- phosphorous, in, 1, 259, 278, 470
- pressure changes, 3, 111-113
- production of ozone in, 1, 22, 94-95
- pulsation, 3, 110-111
- rate of in air, 6, 21
- rays, by, 4, 501-503
- residual glow, 3, 472
- resistance, 3, 113-115, 226; 4, 288-289
- rigidity, 4, 177-178
- silent, 7, 143
- silver, effect in, 1, 314
- spectrum from, 1, 89; 3, 448-449

**Discharge—cont.****electrical—cont.**

- streamer, 3, 95-96, 108-110, 224
- striations in, 3, 95-96
- sulphur, in, 1, 470
  - dioxide, 2, 154
- temperature, 3, 88-89
- Tesla coil, from, 4, 169-182
- Torpedo fish, from, 9, 94
- ultraviolet light from, 1, 428
- use of rotating mirror, 3, 108-110
- vacuum, in, 1, 32
- voltage effects, 6, 167-180
- water, to, 1, 32
- electromagnetic, 4, 287
- lighting, 4, 176
- Discharger, micrometer, 3, 98-99
- Discontinuities in crystals, 3, 493
- Discords, 4, 384
- Discovery of,
  - accumalator, 6, 375
  - actinium, 5, 512; 6, 40
  - alizarin, 2, 245
  - alkali metals, 6, 262-274
  - aluminium, 3, 496
  - americium, 10, 254-255
  - ammonia, 2, 246; 3, 28
  - anthracene, 2, 245; 9, 100
  - antipyrine, 3, 370
  - argon, 4, 400; 5, 466
  - atomic spectra, 1, 354-359
  - benzene, 2, 56, 241, 254; 3, 262; 4, 157; 9, 98-100
  - Brownian motion, 7, 164
  - butene, 3, 362
  - capacitance, 2, 78-82
  - carbon tetrachloride, 4, 157
  - carotene, 10, 228
  - chlorine, 2, 265
  - chrysoidine, 3, 367
  - coherer, 4, 336; 5, 234
  - colour photography, 4, 479
  - conductors, 4, 517
  - contact electricity, 5, 51-52
  - critical point, 2, 294-310; 5, 362
  - curium, 10, 254-255
  - cyanine, 10, 129
  - detonation, 6, 300-301
  - deuterium, 10, 16-18, 47
  - Dewar vessels, 5, 455
  - diamagnetism, 1, 83; 2, 88-93

Discovery of—*cont.*

diazonium salts, 7, 199–204  
 distillation in vacuo, 9, 233  
 eddy currents, 2, 58–67  
 elements, 2, 315–321  
   by spectroscopy, 1, 356–357  
 electrical induction, 3, 466  
 electrode polarisation, 5, 484  
 electrolysis, 2, 494  
 electromagnetism, 4, 72  
 electrophotometry, 3, 8  
 fluorine, 5, 95  
 galvanic battery, 5, 53  
 gas expansion law, 4, 105–106  
 helium, 4, 454–455; 5, 466; 8, 32; 9, 312–313  
 hexachlorobenzene, 9, 96  
 hexachloroethane, 9, 96  
 hydrazine, 7, 196  
 hydrazoic acid, 7, 197  
 hydrofluoric acid, 5, 85  
 hydrogen, 5, 282  
 indanthrene, 9, 25  
 indophenol, 3, 367  
 infrared, 1, 529; 3, 268; 9, 223  
 insulators, 4, 517  
 iodine, 9, 94; 10, 332–333  
 ionium, 6, 280  
 isomers, 6, 25  
 kairine, 3, 370  
 kanalstrahlen, 6, 232  
 krypton, 5, 466–476  
 light polarisation, 2, 168  
 liquid carbon dioxide, 5, 361  
 mauve, 2, 240; 3, 369  
 mauveine, 9, 21  
 metal in spectra, 1, 509–515  
 methyl chloride, 3, 31–32  
 mutarotation, 7, 381  
 naphthalene, 9, 100  
 neon, 5, 159–160, 466–467  
   isotope, 7, 296  
 neptunium, 10, 254–255  
 neutrons, 9, 415–418, 496; 10, 108  
 niobium, 2, 131  
 nitrogen, 4, 488  
   iodide, 9, 94  
 osmosis, 7, 5  
 ozone, 2, 362–363  
 Peltier effect, 5, 66  
 phosphorous, 9, 26

Discovery of—*cont.*

photoconduction, 3, 139  
 photographic sensitisation, 10, 128  
 photography, 4, 39–40  
 platinum ammonium compounds, 2, 249  
 plutonium, 10, 254–255  
 polonium, 5, 512; 6, 40  
 potassium, 6, 269  
 powder method, 8, 318–320  
 radioactive barium, 5, 512  
 radioactivity, 5, 508  
 radium, 5, 512; 6, 40, 52–53; 8, 450  
 refrigeration, 5, 361  
 saccharin, 3, 373, 376  
 sodium, 6, 267  
 solid carbon dioxide, 3, 22; 4, 160; 5, 361  
 tetrachloroethylene, 9, 96  
 thallium, 1, 442–444  
 thermoelectricity, 3, 270; 5, 64  
 titanium, 2, 131  
 toluene, 9, 100  
 tropeolines, 3, 367  
 uranium, 2, 131  
 vanadium, 2, 124, 131; 2, 500  
 voltaic pile, 3, 268; 5, 53  
 water electrolysis, 8, 343  
 weight of air, 2, 285  
 X-rays, 4, 485, 500  
 xenon, 5, 466–467  
 Disease, 2, 303  
 Disintegration,  
   atoms, of, 7, 501–511  
   elements, artificial, of, 9, 13–16  
   nitrogen nucleus, of, 9, 417  
   rate, 7, 182  
   series, 8, 454–459  
   thorium C, of, 8, 133  
 Dislocations, 3, 493  
 Disodium,  
   acetic ester, 1, 575  
   dihydrogen silicate, 1, 331–332  
   hydrogen,  
     arsenate, 3, 399  
     phosphate, 1, 332  
       seeding by, 3, 399  
       supersaturation, 3, 399  
 Disonance, 4, 384  
 Disorder, 6, 355

- Dispersion,  
 azides, of, 7, 188  
 chromatic, 1, 122  
 crossed axial plane, 5, 548  
 glass, of, 5, 444-445  
 internal, 1, 84-89  
 molecular, 6, 164  
 spectroscopy, of, 4, 66  
 theory, 3, 240-247
- Displacement method for metal production, 1, 285
- Dissipation of energy, 2, 420-423
- Dissociation and spectra, 7, 366  
 acids, of, 7, 336  
 alkalis, of, 2, 366  
 concept, 3, 544  
 constants of acids, 7, 198  
 electrolytic, 6, 90-103  
 gases, of, 3, 377-393  
 theory, 5, 334  
 volume change, 6, 102
- Distance,  
 action at a, 1, 64, 71, 143-149; 2, 79, 230, 233, 238, 372-382, 529-539  
 chemical action at, 1, 236  
 intermolecular, 9, 507-508  
 measurement, 4, 361-364
- Distillation,  
 acoustic, 9, 291  
 coal, of, 1, 378  
 coppers, 2, 276  
 destructive, 9, 98  
 hydrogen, fractional, of, 10, 18  
*in vacuo*, 5, 361; 9, 233  
 mercury, of, 4, 227  
   fractional, 8, 339  
 steam, 6, 11
- Distortion of bubbles, 8, 71-73
- Distribution of energy in spectra, 8, 236-243  
 velocities, 5, 35-38; 7, 497-498; 8, 239
- Disturbance, magnetic, 1, 435-441
- Disulphoanthraquinone, 2, 244-245
- Diterpene, 5, 259
- Diurnal magnetic variation, 1, 9-12, 72-73
- Diver, Cartesian, 5, 12
- Divergence of X-rays, 7, 347
- Divided ring electrometer, 1, 335-337
- Divisibility of space and time, 3, 228
- Dobereiner lamp, 7, 406
- Dodecahedron, 4, 118; 7, 335
- Dog, carotenoids in, 10, 235
- Dolezalik electrometer, 7, 490; 8, 47-55
- Domains, 10, 460
- Domestic,  
 electricity, 6, 376  
 heating, 3, 390-393; 7, 413  
 science, Rumford's work, 2, 275-276
- Doppler effect, 4, 196  
 explosion front, in, 3, 440-443  
 glow discharge, in, 9, 126  
 spectra, in, 8, 239
- Double absorption, microwave, 5, 23-25  
 beam spectrometer, 1, 348-349  
 bonds, effect on refractive index, 6, 157, 162  
 cathode, 6, 320-322  
 decomposition, 1, 20-21, 127-130; 2, 179  
 esters, 1, 329  
 refraction (*see birefringence*)  
 salts, 1, 329  
 scattering, 9, 363; 5, 491
- Douk, 2, 277
- Drainage of bubbles, 8, 89-99
- Driven pendulum, 8, 199-201
- Drops, 6, 15-16  
 liquefied gases, of, 7, 230-232  
 photography of, 10, 8-14  
 spherical, 1, 49-54  
 splash of, 4, 291-320  
 surface tension, and, 10, 7-14
- Drinking water,  
 impurities, 2, 260-264  
 purifying, 6, 395
- Dripping-pans, 2, 276
- Drugs,  
 effect on muscle response, 5, 418-419  
 from coal tar, 3, 369-372
- Druses, 4, 57
- Drying houses, 2, 276
- Dual nature of light, 8, 510-519
- Dualism of electricity, 8, 118-119
- Ductility, 8, 361-362  
 alloys, of, 6, 425-426

**Ductility—cont.**

copper, of, 9, 2

crystal structure, and, 9, 2

Dulong and Petit's law, 5, 190-196; 7, 391-401

and carbon, 6, 83-85

radiation law, 5, 237-240

Dumbell radiator, 4, 311

Dupin's cyclides, 9, 517-536

Duralumin, 9, 214

**Duration,**

bubbles, of, 8, 73-78

fluorescence, of, 3, 253-254

**Dust and disease, 2, 303**

clearing by discharge, 5, 234

contents of, 2, 302-303

free air, 8, 136, 311-312

movement of, 7, 164

optical contact, 2, 232

particles in atmosphere, 2, 156-157; 8, 311-312

problem of, 2, 302-313

shadows, electrical, 4, 503

**Dutch metal, 4, 346****Dyeing,**

formaldehyde in, 9, 23

mercerised cotton, of, 1, 37

metallic salts in, 9, 23

methods, 9, 21-22

power, 3, 365-366

silk, of, 1, 410

wool, of, 1, 410

**Dyes, 9, 17-25**

acid, 9, 22

anthraquinone, from, 9, 103

azo-, 2, 190-197

basic, 9, 22

black, 6, 417

chemiluminescence, 9, 219-220

coal-tar, from, 3, 364-369; 9, 100-101

colloidal properties, 9, 72

cyanin, 10, 129-141

fixing, 2, 506-509

flowers, extraction from, 10, 11-24

insects, in, 9, 261

isocyanin, 10, 130-141

lichens, from, 9, 24

methyl chloride in synthesis, use of, 3, 34-35

natural, 9, 114-121

**Dyes—cont.**

1 ton coal, 3, 365-366

organic, 1, 548

polishing, use in, 5, 395

production in England and Germany, 3, 173

sensitising for photography, 10, 128-129

sulphonic acid, 9, 22

synthetic, 1, 397-412; 2, 184-192, 240-245

synthesis of natural, 10, 112-127

temperature, effect of, 5, 465

theory, 5, 525-537

variety of, 3, 367

vats for, 5, 276

**Dynamical energy, 1, 199 (see also kinetic energy)**

similarity, law of, 7, 440-444

theory of,

electricity, 1, 30-33

heat, 1, 30; 5, 324-358; 8, 103

light, 5, 324-358

magnetism, 1, 30-33

**Dynamics and optics, 9, 206**

airships, of, 7, 436

chemical, 1, 18-31

fluids, of, 7, 431-444 (see also hydrodynamics)

golf-balls, of, 7, 104-119

submarines, of, 7, 436

theory of, 4, 249

**Dynamo, 4, 423**

de Meriten's, 3, 216-217

design, 6, 376

simple, 3, 306-311

**Dyne, 5, 552****Dysprosium,**

atomic heat, 7, 401

volume, 7, 401

weight, 1, 500-509

**E****E group in solar spectrum, 3, 202, 205****E.M.F. (see electromotive force)****E.M.U. of charge, 5, 552****E.S.U. of charge, 5, 552****Ear,**

combination tones, and, 4, 385-389

**Ear—*cont.***combination tones, and—*cont.*

rotation, 8, 213

non-linearity, 4, 386

**Earth (see also *terrestrial*)**

axis, 1, 119–120

centre, 7, 51

current, 1, 435–441

crust, 7, 54

density, 5, 300–303; 7, 55

diameter, 7, 55

electric charge on, 1, 340–347; 4, 172

evolution, 7, 16

Fuller's 10, 291

interior pressure, 8, 348

interior temperature, 1, 374

kinetic energy, 1, 417–418

magnetic field, 1, 3, 9–12, 435–441;  
4, 425

disc rotating in, 4, 430–444

heating by rotation in, 2, 11–12

magnetisation by, 3, 18–20

mass, 4, 353

metals in, 6, 266–267

motion of aether near, 4, 189–204

orbit, 8, 191, 226

pressure at centre, 8, 348

rotation and vortices, 10, 187–190

sound reflection by, 8, 369

structure, 7, 16

velocity, 8, 190–191

**Earthenware,**

membrane, 2, 217

pots, membranes in, 7, 5

**Earthquakes, 7, 55**

detection, 4, 370

origin, 8, 292

**Eau de Cologne, 5, 259****Ebonite,**infrared transmission, 3, 209–211; 8,  
284

refraction of microwaves, 5, 18

resistance, 4, 435; 5, 559

and temperature, 4, 535; 5, 459

strained, microwave birefringence,  
5, 23**Ebony charcoal, 6, 395****Echelon spectroscope, 7, 376**

transmission gratings, 10, 203

**Eclipse and light mass, 8, 192**

expedition to Oran, 2, 254

**Eclipse and light mass—*cont.***

solar, 8, 214–215

Economic power, British in 1851, 1,  
34–41Economics of electricity transmission,  
6, 376

synthesis, 1, 275

**Eddy, 7, 437**

currents, 1, 140; 2, 89–90; 3, 304

discovery, 2, 58–67

heating by, 4, 73

in iron, 4, 73

repulsion by, 8, 506–509

formation, 3, 296

viscosity, and, 5, 220–232

Education and science in 1851, 1, 35–36

**Effect,**

Barkhausen, 10, 460

Compton, 9, 189–190, 201, 230–231,  
379–380, 415

fountain, 10, 465–468

isotope, 10, 60–70

and uncertainty principle, 10, 49–  
57impurity, Graham's work, 2, 208–  
209

photoelectric, 9, 201

piezoelectric, 9, 283; 10, 172–177

pinch, 7, 374–377

pyroelectric, 10, 172

Raman, 9, 244, 226, 278–280; 10,  
405–413

Effective thickness, mhoic, 4, 99–100

**Efficiency,**

electric motor, of, 6, 375–376

lamps, 7, 46

transmission, of, 6, 376

**Effluvioluminescence, 4, 507****Effusion,**

Graham's law, 2, 218–219

gases, of, 2, 38–44, 218–219, 221–  
233

pyrometry, 5, 246–247

rates, 2, 40–44, 221–233

**Egg,**

boiling, 10, 219–220

phosphorescence, 4, 377; 5, 464; 7,  
81

yolk, 10, 228

**Egyptian glass, 9, 155–157****Eider-down, 2, 227**

- Einstein theory of Brownian motion, 7, 180
- Elasticity, 8, 346-362  
 aether, and 6, 288  
 axes, 1, 294-304  
 definition, 8, 346  
 ellipsoid, 1, 293-304  
 gases, of, 8, 347  
 limits, 8, 361  
 motion, and, 3, 136-137  
 rubber, of, 8, 255  
 solids, of, 3, 60-62  
 temperature, and, 4, 266-270; 5, 464; 8, 352-360  
 theory of, 3, 136-137; 3, 60-62  
 Young's work, 5, 277-278
- Elective affinity, 1, 127-130
- Electric action at a distance, 2, 372-382
- Electric arc (*see arc*)
- Electric  
 axis, 9, 283  
 charge on,  
   earth, 1, 340-347; 4, 172  
   rain, hail and snow, 1, 344  
 conduction (*see conduction, electrical and resistance*)  
 convection in liquids, 3, 478-479  
 current (*see current*)  
 damping, 1, 184  
 discharge (*see discharge, electrical*)  
 dust shadows, 4, 503  
 effluve, 4, 502  
 energy and heat, 4, 1-6  
 fan, 4, 89-90  
 field and ion velocity, 8, 179-180  
   effect on,  
     chemical reaction, 7, 102  
     positive ions, 6, 235-247  
     spectra, 8, 239  
   atoms, in, 7, 502  
   expansion of dielectrics in, 3, 480  
   particles in, 8, 522-536  
 fluid, 4, 154; 5, 408  
 force, 1, 61, 227-240; 2, 68-69; 4, 95  
 furnace, 7, 55-56, 239-246  
   temperatures, 7, 239  
 fusion of wire, 1, 366  
 gas-lighter, 4, 342  
 heating, 7, 239  
   effect, 1, 29-33, 368
- Electric -*cont.*  
 images, demonstration, 4, 94  
 induction, 1, 96-106, 263-267  
   discovery, 3, 466  
   machines, 3, 466-471 (*see also machine*)  
 inertia, 8, 216-221  
 insulation, 1, 96-106, 185  
 intensity, 1, 95-105, 365-441  
 interference of telegraphy, 1, 435-441  
 lamp, 1, 246; 7, 46  
   infrared spectrum, 1, 530; 7, 356  
 lighting of ships, 4, 97  
 lines of force, 2, 68-69; 4, 95  
 measurement of temperature, 2, 342-352  
 melting of steel, 7, 374-377  
 meter, 4, 88-90  
 motor, 4, 89-92  
   demonstration, 4, 82-86  
   efficiency, 6, 375-376  
 neutralisation by flames, 1, 264  
 oscillations, 3, 483  
 permittivity, 2, 78-82  
 phosphorescence (luminescence), 1, 311  
 photography, 4, 494-495  
 polarisation, 1, 266  
 potential, 1, 366-369  
   and heating effect, 1, 368  
 power, 6, 182  
 production of nitrates, 6, 181-182  
 properties of,  
   crystals, 10, 142-147, 172-177  
   flames, 7, 1-4  
   proteins, 10, 431-342  
 pulse from eye, 5, 419  
 radiation, 3, 485  
   detectors, 4, 341  
 radiometer, Crookes', 6, 260  
 ray, polarisation of, 5, 11-26  
 resistance (*see resistance*)  
 response of,  
   metals, 5, 427-438  
   muscle, 5, 421  
 shadows, 4, 492-494  
 shock, 1, 334  
 spark (*see arc*)  
 standards, 5, 452  
 stress, 3, 478-80

Electric—*cont.*

- striations, 7, 36–45 (*see also discharge*)
  - stimulus, 5, 417–440
  - supply, 4, 97, 136, 6, 375
  - syntony, 4, 326
  - telegraph, 1, 240; 8, 216
  - Telegraph Company, 1, 96
  - tension, 1, 365–369
  - theory, Maxwellian, 8, 213
  - thermometers, limits, 7, 283
  - tuning-fork, 3, 522; 4, 436–437
  - units, 3, 311
  - vibrations, 8, 198–211
  - waves, 5, 368–371
    - emission, 4, 323
  - wind, 4, 494
  - Zeeman effect, 8, 239
- Electrical engineering, Kelvin's work, 6, 375 377
- Electricity,
- atmospheric, 1, 334–347; 6, 372–373
  - chemical affinity, and, 1, 136–139; 4, 282; 9, 107
  - contact, 1, 180; 3, 227–256; 5, 50–83
    - copper-copper oxide, 3, 237
    - measurement, 5, 58–61, 80–83
    - silver-silver iodide, 3, 238
    - theory, 8, 563
  - cost, 7, 413
  - domestic, 6, 376
  - dualism, 8, 118–119
  - frictional, 1, 261; 5, 560
  - history, 3, 466–468
    - of theories, 5, 554–555
  - identity of various types, 2, 67–72
  - intensity of, 2, 67–72
  - matter, and, 8, 115–119
  - measurement of contact, 5, 58–61, 80–83
  - nature of, 5, 408
  - physiological effects, 1, 366–369
  - pneumatic, 1, 111, 400
  - positive, 6, 232–247, 314–344
  - quantity, 1, 95–105, 305–309; 2, 67–72
  - resinous, 5, 51, 56
  - static, 1, 60, 263–267
  - theory of, 1, 59, 96–106, 184–186, 237; 2, 372–382; 4, 154
    - electronic, 5, 551–569

Electricity—*cont.*

- theory of—*cont.*
    - fluid, 1, 29
    - Maxwellian, 8, 213
    - transmission, 1, 99–105; 6, 375
    - vitreous, 5, 51, 56
- Electrification at low temperatures, 6, 210–211
- friction, by, 5, 560
  - pith-ball, of, 4, 94
  - sea-water, of, 5, 560
  - water-drops, of, 5, 560
  - waterfalls, of, 5, 560
- Electrochemical,
- cells, 1, 200, 236–237
    - heat evolution, 1, 186
  - equivalents, 2, 73–75; 9, 400
  - theory, 1, 136–139
    - of chemistry, 2, 177–183
  - work by Faraday, 2, 267–268; 5, 483; 9, 107, 386–410
- Electrodeposition of platinum, 1, 259
- Electrode,
- carbon, 7, 239–246
    - purification of, 3, 82
    - definition, 2, 73
  - effect of material, 3, 107–108
  - graphite, 7, 239–246
  - magnesium, 3, 186–199
  - polarisation, 5, 484–486
  - shape, 3, 99–101, 106
- Electroluminescence, 4, 507; 7, 67–70 (*see also discharge, electrical*)
- Electrolysis, 1, 136–139, 141, 159, 164–172, 256–262; 2, 67–78; 5, 552
- acetates, of, 8, 344
  - charge-mass ratio, 5, 405–406
  - colloids, of, 6, 188–189
  - copper sulphate, of, 6, 183–185
  - definition, 2, 73
  - discovery, 2, 494
  - effects of light, 3, 8–10
  - Faraday's laws, 1, 137–139, 164–172, 365; 2, 73–75; 9, 397–405
  - Faraday's work, 2, 267–268; 5, 483; 9, 107, 386–410
  - fluorides, of, 5, 87, 89
  - fused calcium fluoride, of, 5, 89–91
  - heat change in, 4, 1–6



**Electrolysis—cont.**

- Helmholtz's work, 4, 394
- high pressures from, 2, 295
- hydro fluoric acid, of, 5, 93–95
- ions, in, 5, 483–499
- Kolbé, 1, 271; 8, 344–345
- liquids, of, 6, 183–189
- malonates, of, 8, 344–345
- mechanism, 5, 484–499
- metals, of, 2, 340–341
- Ohm's law, 5, 486
- succinates, of, 8, 344–345
- sulphuric acid, of, 8, 343–344
- water, of, 1, 98, 261; 2, 72; 5, 485; 8, 343; 10, 18, 49

**Electrolytes, 9, 71**

- colligative properties, 7, 14
- colloidal, 9, 64–72
- conductivity, 5, 491–493; 9, 394–397 and temperature, 4, 518
- definition, 2, 73
- degree of dissociation, 5, 486–487; 495–498; 6, 90–103
- vapour pressure, 7, 14
- weak, 9, 71

**Electrolytic,**

- gas, 6, 397–404
  - density on charcoal, 6, 218
  - heat of adsorption on charcoal, 6, 109–110
- junction, 6, 186–187
- production of,
  - alkali metals, 1, 284–285
  - copper, 1, 284
  - ozone, 1, 22

**Electromagnet, lifting power, 4, 9****Electromagnetic,**

- discharge, 4, 287
- heating, 4, 73
- induction, 3, 300–311
  - demonstration, 4, 72–74
  - theory, 5, 564
- origin of mass, 8, 119, 129
- oscillators, 4, 18–19
- radiation, 3, 485; 4, 7–8, 18–25; 8, 56–65
  - properties, 5, 11–26
  - velocity, 9, 224
- repulsion, 4, 72–92
- screening, 4, 73, 93–103
- sources, 4, 342

**Electromagnetic—cont.**

- spectrum, 7, 447, 487; 9, 224–225
  - absorption by glass, 5, 370–371
- theory, 3, 485; 8, 516–517 and Faraday, 9, 106–107
  - development, 4, 321
  - radiation pressure, of, 6, 150
- waves, 4, 321–349
  - predicted properties, 4, 324
  - short, 5, 14–26

**Electromagnetism, 3, 216–226**

- discovery, 4, 72
- Faraday's work, 2, 54–55, 58–67; 3, 270

**Helmholtz's work, 4, 394****Electrometer, 1, 334–347, 3, 476–477, 560; 7, 495 (see also electroscope)**

- attracted disc, 4, 98
- common-house, 1, 337–338
- Cuthbertson's, 1, 184
- Dellman's, 5, 57
- divided-ringed, 1, 335–337
- Dolezalik, 7, 490; 8, 47–55
- quadrant, 5, 53
- portable, 1, 338–339
- radiation detector, 4, 341

**Electromotive force, 1, 365–369; 4, 86, 426 (see also voltage)**

- cells, of, 6, 360–361
- contact, of, 5, 50–83
- origin, 5, 563

**Electron, 4, 490–493; 5, 36–49, 99–124, 405–416 (see also cathode rays and  $\beta$ -rays)**

- absorption coefficients, 5, 47
- aether, and the, 5, 564–567
- air, in, 4, 497; 5, 46–48; 8, 59–60
- alkali chlorides, effect on, 5, 37
- atomic number, and, 8, 132
- atoms, in, 6, 135–149; 8, 58
- bombardment of,
  - alkali metal chlorides, 5, 37
  - glass, 5, 100
  - quicklime, 5, 101–102
- capture by  $\alpha$ -particles, 8, 522–536
- charge, 5, 407, 553; 7, 178, 9, 205
- mass ratio, 5, 405
- chemistry, and, 8, 131
- collision cross-section, 5, 47–48

**Electron—*cont.***

combustion, in, 7, 4, 410  
 cosmic effects, 5, 414–416  
 conversion of diamond to graphite, 5, 103  
 Crookes, early investigation by, 3, 41–59  
 density in,  
   metals, 5, 412  
   phthalocyanines, 10, 224–225  
 diffraction, 9, 190–192, 210–213, 357–364  
   gases, of, 9, 361  
   reflection, by, 9, 361–364  
   sputtered films, of, 9, 362  
   surfaces, of, 10, 244–251  
 dimension, 5, 47–48  
 distribution in crystals, 8, 330–331  
 double-scattering, 9, 363  
 electric discharges, in, 6, 167–180  
 electricity and, 5, 551–569  
 emission by hot bodies, 5, 407; 7, 492–500  
   cooling by, 7, 495  
 etching of glass, 5, 100  
 focusing, 5, 99–100  
 heat of evaporation, 7, 495–496  
 heating effect, 3, 54–57; 7, 492–500, 8, 104;  
 history of study, 5, 36–37  
 inertia, 3, 57–58; 5, 551  
 magnetic field, effect of, 3, 53–54; 5, 39–41  
 mass, 5, 407; 9, 205  
   charge ratio, 5, 48–49  
 metals, in, 5, 411–414  
 methods of emission, 8, 56  
 number in,  
   air, 8, 59–60  
   atom, 8, 58  
   shells, 8, 327  
 optics, 9, 357–364  
 orbits, 8, 59  
 $\beta$ -particles, and, 7, 501  
 periodic table, and, 8, 132  
 photoelectric effect, from, 5, 407  
 photographic effects, 4, 494–497  
 photon collision, 9, 5  
 positive, 9, 499; 10, 37–38, 253  
 properties, 4, 502  
 radium, from, 5, 407

**Electron—*cont.***

radium, from—*cont.*  
   velocity, 5, 413–414  
 repulsion, 5, 566–567  
 scattering of X-rays, 8, 58  
 secondary, 7, 491  
 shells, 7, 491; 8, 131, 327  
 slow, 7, 487–491  
 stream, diffusion, 8, 180  
 sun, from, 5, 414  
 thermionic emission, 5, 407; 7, 492–500  
 theory of mass, 5, 409  
 valency, 8, 131  
 velocity of emission, 5, 413–414; 7, 496–498  
   X-ray ejection, 8, 54–61  
   wave nature, 9, 204–213  
   wavelength, 9, 207–213, 358  
   X-rays, formation of, 4, 503; 7, 506–507  
 Electronegative elements, 1, 31; 3, 421–422; 5, 562  
 Electronegativity, 1, 136–139; 8, 117  
 Electronic charge, 5, 407, 553; 7, 178; 9, 205  
   mass, 5, 407; 9, 205  
   structure of,  
     active nitrogen, 8, 486–487  
     atoms, 8, 327  
     nitrogen, 8, 486–487  
   theory of,  
     electricity, 5, 551–569  
     valency, 8, 115–119  
   transitions, 9, 225  
 Electro-optical effects of quartz, 3, 536–537  
 Electrophorous, 3, 466; 4, 342  
 Electrophotometry, 3, 8–10  
   discovery, 3, 8  
 Electropositive elements, 1, 31; 3, 421–422; 5, 562  
 Electroscope, 7, 449  
   (*see also electrometer*)  
   air-gap, 4, 335–336, 341  
   gold-leaf, 1, 263; 5, 50  
   Peltier's, 1, 335  
   pith-ball, 4, 94  
 Electrostatic charge on earth, 1, 340–347; 4, 172  
   measurements, 3, 476–477

- Electrostatic charge on earth—*cont.*  
 screening, 4, 93–96
- Electrostatics, Faraday's work, 2, 78–82
- Electrosynthesis, 8, 343–345
- Elementary particles, 5, 404–416  
*(see also particles)*
- Elementary photography, 7, 312–324
- Elements,  
 allotropy, 1, 55–58  
 artificial disintegration, 9, 13–16  
 atomic,  
   heats, 2, 234–325  
     at 50°, 7, 401  
   radii, 8, 326  
   refraction, 2, 138, 540–545  
   volumes, 7, 401  
   weight, 1, 500–509; 2, 540–541; 5, 190–195  
 classification, 1, 500–508; 2, 326–329, 501; 3, 404, 418–420  
 crystal structure, 7, 128, 325  
 definition, 2, 314–315; 8, 113–135, 332  
 discovery, 2, 315–321  
   by spectra, 1, 356–357; 2, 318–322  
 electronegative, 1, 31; 3, 421–422; 5, 562  
 electronic structure, 8, 327  
 electropositive, 1, 31; 3, 421–422; 5, 562  
 group V, of, 2, 124–130  
 history of, 2, 493  
 isotopes of, 10, 45–46  
 magnetic character, 3, 419  
 odd and even, 9, 16  
 origin, 3, 403–426  
 periodic classification, 2, 326–329, 501; 3, 404, 418–420  
 relative abundance, 10, 272  
 specific heats, 5, 189–196  
 sun, in, 1, 351–356  
 symmetry, 7, 122–134  
 transmutation, 7, 248; 9, 263–264, 495–499; 10, 22–27  
 transuranium, 10, 254–256  
 ultraviolet spectra, 3, 257–267  
 valencies, 2, 325  
 X-rays, 7, 451
- Elevation of boiling point, 5, 494
- Elliot bridge, 4, 52
- Ellipsoid of elasticity, 1, 293–304  
 optical, 5, 541–550; 7, 327–329
- Ellipsoidal molecules, 4, 121
- Elliptical,  
 horn, 5, 479  
 polarisation, 2, 271–272  
 X-ray spots, 7, 347
- Elongation of iron by magnetisation, 1, 523–528
- Emanation theory, 6, 154
- Emanations *(see actinon, radon and thoron)*
- Embryonic heart, 9, 294
- Emerald, 4, 235
- Emery, 5, 393
- Emission and absorption of light, 1, 350–351, 382–383; 3, 63, 272  
 electrical waves, of, 4, 323  
 electrons, of, 8, 56  
 infrared radiation by  
   air, 1, 381  
   ethylene, 1, 381–382  
   flames, 9, 228  
   gases, 1, 350  
   oxygen, 1, 381  
 light by,  
   flames, 5, 27–35  
   hydrogen flame, 1, 494  
   nitrogen, active, 7, 306  
   theory, 1, 350, 385–389  
 sound, standard, 8, 363–364, 368  
 thermionic, 5, 407; 7, 492–500  
   temperature, and, 7, 494  
   theory, and, 7, 493  
   velocities, and, 7, 496–498
- Emulsification, 9, 292
- Emulsions,  
 photographic, 10, 140  
 rarefaction with height, 7, 173
- Enantiomorphs, 6, 29
- Encyclopedia Britannica, 2, 52
- Energy and heat, 1, 196–201, 235, 372–373; 2, 77, 420; 4, 1–6  
 activation, of, 10, 385–403  
 available, 6, 348–360  
 categories of, 1, 196–201  
 chemical, 1, 373–380  
 condenser, of charging, 3, 95  
 conservation, 4, 100; 6, 348–360  
   in nature, 1, 370–380

**Energy and heat—cont.**

- dissipation, 2, 420–423; 3, 36–37
- distribution in spectra, 8, 236–243
- effect of motion, 4, 197
- equipartition, 5, 329–358; 8, 103
- invention of term, 5, 277
- Kelvin's work, 6, 348–360
- kinetic, 1, 199, 371–372, 414
  - of earth, 1, 417–418
- loss by hysteresis (*see hysteresis loss*)
  - in discharges, 4, 175
- natural sources, 6, 375
- pendulum, in 1, 371–372
- potential, 1, 198–199; 5, 277
- quantisation, 8, 107
- source in,
  - stars, 9, 264
  - sun, 1, 416–417
- spring, in vibrating, 1, 372
- transfer in spectra, 8, 241–242
- transformation, 1, 196–201
- translation, of, 4, 408
- work, and, 1, 370–380
- zero-point, 10, 49–67

**Enfleurance, 6, 11****Engine,**

- air, 1, 235
- heat, 1, 198; 2, 420
- internal combustion, 9, 104
- Otto, 3, 216–217
- running-in, 10, 250–251
- steam, 1, 235; 2, 420
- theory, 1, 182–183

**Engineering, electrical, Kelvin's work, 6, 375–377****England,**

- dye production, 3, 173
- economic power, 1, 34–41

**English,**

- glass thermometer, 5, 450
- patent law, 3, 173
- tortoiseshell butterfly, 9, 261

**Entropy, 6, 348–366**

- function of state, 6, 354
- liquid helium, of, 10, 464
- universe, in, 6, 355

**Enzymes, 6, 37**

- definition, 8, 27
- effect of pH, 9, 320
- nitrogen-containing, 7, 195
- oxidising, 10, 338

**Enzymes—cont.**

- protein, 10, 414
- substrate complex, 8, 29–31

**Eosin, 3, 368**

- chemiluminescence, 9, 219–220
- fluorescence, 4, 507; 7, 81; 9, 277
- photographic sensitisation, 9, 220; 10, 129

**Eotinine, 1, 545****Epichlorohydrin, 8, 286****Epidermis, 2, 303**

- action of radium, 6, 49
- leaf, 5, 372–373

**Epidote,**

- microwave birefringence, 5, 22
- zoned crystals, 4, 53

**Epiphasic pigments, 10, 231****Epipolised light, 1, 84–89****Epsom salts diffusion in,**

- liquids, 1, 393–396
- water, 2, 213–215

**Equation,**

- Arrhenius, 10, 385–403
- Clausius-Clapeyron, 7, 17
- Laplace's, of motion, 8, 189
- Maxwell's, 8, 516–517; 9, 549
- Rankin, 7, 71

**Equilibrium,**

- chemical, 2, 422
- concept of, 3, 544
- electrolytic, 5, 498
- heat of reaction, and, 2, 149–150
- vapour pressure, 7, 8
- ionic, 6, 101

**Equipartition of energy, 5, 329–358; 8, 103****Equivalent conductivity, 5, 492–493**

- mechanical of heat, 1, 183
- weights, 5, 553

**Equivalents, electrochemical, 9, 400****Erbium, 1, 357; 3, 414–416**

- discovery, 2, 316–318

**Ernite, 2, 504****Eriometer, 9, 324****Eruptions on sun, 4, 172****Erythronic acids, 9, 198****Erythrosin, 3, 368**

- photographic sensitisation, 10, 129

**Erythroxin, 2, 243****Escape velocity, 5, 470**

**Essence—cont.**

heliotrope, 3, 372

mirbane, 3, 372

**Essential oils, 6, 10–14**

action on photographic plate, 5, 259

and phosphorous glow 4, 15; 9, 27

**Esters,**

acid, 1, 329

aliphatic, 1, 547–548

double, 1, 329

hydrolysis, 1, 575; 8, 29

infrared transmission, 8, 287

neutral, 1, 329

phosphorescence, 4, 377

silicon-substituted, 2, 390

synthesis, 1, 575

viscosity, 4, 135–154

**Estuaries, 7, 431****Etching,**

glass, of, 4, 246–247

electrons, by, 5, 100

hydrofluoric acid, by, 1, 259

metals, 4, 125

**Ethane, 1, 156**

amine derivatives, 1, 544

combustion, 6, 301–313

effect of cooling, 6, 310–311

critical constants, 3, 315

diazide, 7, 201–202

electrosynthesis, 8, 344

ethylene, from, 10, 64–66

explosion products, 6, 312–313

flame velocity, 9, 468

formula, 1, 536; 2, 196–198

high pressure explosion, 6, 312

hydrogenation, 9, 250–351

molecular structure, 1, 558, 560–562, 564

ozone oxidation, 6, 304

preparation of pure, 2, 498

silico-, 2, 391

synthesis, 1, 271, 545; 2, 489–492; 8, 344

thermal decomposition, 9, 349–351

**Ether, 1, 63, 76, 161; 3, 122 (for the ether see aether)**

azide, 7, 201–202

boiling point, 6, 75, 429

charcoal, adsorption on, 6, 106

critical,

opalescence, 4, 108

**Ether—cont.**critical—*cont.*

point, 2, 297; 4, 109; 5, 361

temperature, 6, 75, 429

discharge, in, 7, 70

ethyl methyl, 1, 155

evaporation rate, 2, 398–400

temperature, 6, 75, 429

fluorine, action of, 5, 96

formula, 1, 207, 451

infrared,

absorption, 8, 286

spectrum 3, 212–214

Kelvin's work, 6, 373

magnetism, 1, 68

molecular structure, 1, 403

mutarotation in, 7, 384

nitrogen, and active, 7, 309

palladium, absorption by, 2, 47

phosphorous glow, extinction of, 4, 15

p,V,T, data, 4, 107 109

refraction, 6, 161

refrigeration, 2, 421; 4, 218

solid carbon dioxide bath, 3, 23

spherical drops, 1, 51

surface reaction, 6, 300

synthesis, 1, 18–21, 274; 2, 211

tears, 3, 348

ultraviolet absorption, 1, 430–431

vapour,

diffusion through, 7, 471

viscosity, 2, 219–221

viscosity, 5, 143–154

water distribution, 5, 527

foams, 4, 26–27

**Etherial (aetherial) constant, 8, 217**

Etherification of alcohol, 1, 159

theory, 1, 18–21; 2, 21; 5, 487

**Ethyl,**

acetate,

acid, 7, 201–202

catalysis, 1, 517

formula, 1, 547–548, 574

hydrolysis, 8, 29

infrared transmission, 8, 287

sodium derivatives, 1, 575

sound from radiation, 3, 152

viscosity, 2, 213

acetoacetate, 8, 287

alcohol, 1, 161, 497

Ethyl—*cont.*alcohol—*cont.*

- air, on liquid, 4, 234
- alumina, reaction with, 1, 162
- azide, 7, 201–202
- beer, determination in, 6, 166
- biological oxidation, 3, 549
- boiling by infrared, 2, 4
- carbon dioxide bath, 8, 272
- catalytic decomposition, 1, 160
- charcoal, adsorption on, 6, 106
- composition of, 1, 19
- critical point, 2, 294–295; 5, 361
- crystallisation, of, 2, 209
- decomposition, 1, 160; 6, 304
- dehydration, 2, 209
- depression of freezing point, 6, 97
- deuterium exchange, 10, 61–67
- dielectric properties, 5, 462
- diffusion of,
  - salts in, 1, 393–396
  - through rubber, 7, 485–486
- dispersion, 3, 245–246
- ethane flame, in, 6, 303
- etherification, 1, 18–21, 76
- fermentation, from, 1, 56
- fluorine, action of, 5, 96
- formula, 1, 156, 207; 2, 199, 483–486
- glass, 4, 263
  - wetting, effect on, 3, 346–347
- gravitational effects, 5, 305
- heat, action of, 1, 478
- infrared,
  - absorption, 1, 493; 8, 273, 280–281, 286, 289
  - spectrum, 3, 212–214
- isomerism, 1, 55
- magnetism, 1, 68
- molecular structure, 1, 403
- osmosis, 7, 5
- oxygen flame, 1, 89
- palladium, absorption by, 2, 47
- refractive index, 3, 245
- solutions, diffusion, 7, 485–486
- spherical drops, 1, 51
- splashes, 4, 291–301
- surface viscosity, 4, 36
- synthesis, 1, 274–275; 2, 141
- tears, 3, 347
- ultraviolet absorption, 1, 430–431

Ethyl—*cont.*alcohol—*cont.*

- vapour, diffusion, 7, 471
- viscosity, 2, 212–213; 5, 142–154
- volatility, 2, 401
- water
  - diffusion, 7, 485–486
  - foam, 4, 26
  - mixtures, viscosity, 2, 212–213
  - phase diagram, 2, 523
  - viscosity, effect on, 7, 440
- aluminium, 1, 53, 58
  - dimerisation, 1, 53
- ammonium iodide, 1, 208–209
- amyl oxalic acid, 1, 521
- antimony, 1, 139
- arsenic, 1, 139
- borate, 1, 391,
- benzene,
  - infrared transmission, 8, 285
  - viscosity, 5, 142–154
- benzoate,
  - light scattering, 2, 172
  - liquid air on, 6, 211
- bismuth, formula, 1, 536
- bistriazoacetate, 7, 198
- bromide,
  - infrared transmission, 8, 285
  - viscosity, 5, 141–154
- (butane), 1, 91, 273
- butyrate, 1, 547–548
  - viscosity, 2, 213
- carbonate, 8, 287
- chloroacetate, 8, 287
- chloride, 1, 156
  - boiling point, 5, 465
  - formula, 1, 451; 2, 199
  - infrared transmission, 8, 285
  - spherical drops of, 1, 51
- crotonate, 1, 576
- cyanide,
  - infrared transmission, 8, 288
  - reduction, 1, 481
- cyanoacetate, 8, 288
- dihydrogen phosphate, 1, 332
- ether (*see Ether*)
- ethyl malonate, 8, 287
- fluoride, 5, 465
- formate,
  - formula, 1, 547–548
  - infrared absorption, 1, 497; 8, 287

**Ethyl—cont.****formate—cont.**

- sound from, 3, 152
- viscosity, 2, 213; 5, 142–154
- hydrogen sulphate, 1, 329, 333
- synthesis, 1, 478
- iodide, 1, 90–91, 451
  - charcoal, adsorption on, 6, 106, infrared,
    - absorption, 1, 493; 8, 285
    - spectrum, 3, 312–314
  - reaction with rosaniline, 1, 572
  - sound from, 3, 152
  - synthesis, 2, 145, 439–440
  - viscosity, 5, 141–154
  - zinc-copper couple, action on, 2, 439–440
- isobutyl ether, 5, 143–154
- lactic acid, 1, 575
- lead, 1, 586
- lithio-mercury, 1, 518–522
- lithio-zinc, 1, 518–522
- mercury, 1, 518–522
  - chloride, 1, 518–522
  - formula, 1, 536
  - iodide, 1, 518–522
- methacrylate, 1, 576
- methyl,
  - ester, 1, 155, 451
  - ketone, 5, 142–154
  - malonate, 8, 287
  - sulphate, 1, 329
- nitrate glass, 4, 263
- oxalate, 1, 519
  - infrared transmission, 8, 287
- para-azoxybenzoate, 9, 513–536
  - transition points, 9, 515
- perchlorate, 1, 329, 332
- phenyl ketone, 4, 378
- potassium sulphate, 1, 329
- propionate, 5, 142–154
- propyl ether, 5, 143–154
- radical, 1, 90, 403
- red, 10, 130
- rosaniline, 1, 572
- sodiummalonate, 10, 118
- sodium,
  - reaction with carbon dioxide, 1, 480
  - use in synthesis, 2, 146

**Ethyl—cont.****sulphate**

- infrared absorption, 1, 349
- sound from, 3, 152
- sulphate, 5, 141–154
- tin, 1, 139
  - formula, 1, 536
- triazooacetate, 7, 198
  - infrared transmission, 8, 288
- valerate, 2, 213
- violet, 1, 572
- zinc, 1, 92–93, 139, 273
  - decomposition, 1, 452
  - formula, 1, 536
  - synthesis, 2, 439–440, 498
  - synthetic use, 1, 518–522
- Ethylamine, 1, 208
  - charcoal, adsorption on, 6, 106
  - formula, 1, 449, 544; 2, 199, 247–248
  - molecular structure, 1, 403, 558–559
  - solubility in water, 2, 247
  - synthesis, 1, 481; 2, 145
- Ethylene, 1, 565–568; 2, 145
  - acetate, 8, 287
  - ammonia, reaction with, 2, 186–187
  - analysis, 2, 478–479
  - azides, 7, 201–202
  - boiling-point, 6, 75–77, 429
  - charcoal, adsorption on, 6, 105, 395
  - chemical properties, 2, 478–479
  - coal, from, 1, 399
    - ethane explosion, 6, 313
  - combustion, 6, 301–303
  - condensation from coal-gas, 5, 322
  - critical, constants, 3, 315
    - temperature, 6, 75, 429
  - derivatives, 7, 204
    - polymerisation, 10, 260–268
  - diamagnetism, 4, 220
  - dibromide, 1, 566–568
    - synthesis, 2, 144
    - viscosity, 5, 414–454
  - dichloride, 1, 566–568
    - internal rotation, 9, 505
    - vapour pressure, 7, 13
    - viscosity, 5, 141–154
  - evaporation,
    - rate of, 4, 324
    - temperature, 6, 75, 429
  - explosion, 6, 302

**Ethylene—cont.**

- flame
    - spectrum, 3, 174
    - velocity, 9, 468
  - formula, 1, 541–542; 2, 193, 198
  - hydrogen combustion, 6, 308
  - hydrogenation, 10, 64–66
  - impurities, 3, 23
  - infrared absorption, 1, 349, 382, 463–466
    - emission, 1, 381–382
    - of liquid, 4, 259
  - latent heat, 6, 77, 431
  - liquefaction, 4, 160
  - liquid, 3, 312–313; 4, 457–459
    - density of, 6, 77
    - flame calorimeter, 4, 470
  - magnetism, 1, 68
  - molecular refraction, 4, 231
    - structure, 1, 565–568
  - oxide, 3, 554
  - oxygen flame velocity, 4, 145–149
  - oxygen liquefaction, use in, 4, 218
  - phosphorous glow, and, 2, 209; 4, 15; 9, 27
  - p,V,T, data, 5, 363
  - polymerisation, 10, 260–268
  - poisoning of platinum catalyst, 9, 399
  - preparation of pure, 4, 218
  - properties, 1, 565–568; 2, 478–479
  - refractive index, 4, 231
  - sound from, 3, 152–153
  - sulphuric acid, reaction with, 1, 478
  - surface oxidation, 6, 300
  - synthesis, 1, 273–274, 477; 7, 481
  - thermal decomposition, 9, 349–351
  - ultraviolet absorption, 1, 430–431
  - viscosity, 2, 219–221
- Ethylenediamine**, 2, 187, 247–248
  - formula, 1, 544
  - hydrate, 2, 247
  - hydrochloride, 2, 247
  - molecular structure, 1, 558–559
- Ethylenetetramine**, 1, 187
- Ethyltriamine**, 2, 187
- Ethylidene chloride**,
  - infrared transmission, 8, 285
  - viscosity, 5, 141–154
- Ethoxy-aluminium**, 2, 499
- Etiolated seedlings**, 8, 375
- Eucalyptus**, 9, 116
- Euclidean space**, 8, 190–197
- Eudiometer**, 1, 472
- Eugenol**, 6, 12
- Euphonion**, 8, 207
- Eupion**, 1, 399
- Euplectella aspergillum**, 7, 63
- Eurhodines**, 5, 533
- Eustatite**, 4, 53
- Eutectic**, 2, 520–526
- Euxenite**, 3, 410
- Evanescent refraction**, 5, 254
- Evaporation**, 2, 398–404
  - cells, from, 3, 92
  - cooling by, 2, 402
  - latent heat, 2, 398–404, 6, 77
    - of crystals, 9, 79
  - rate, 2, 398–404
    - and temperature, 7, 494
  - temperatures, 6, 75, 429; 7, 226
  - theory, 7, 493
- Even elements**, 9, 16
- Evolution**,
  - earth, of, 7, 16
    - heat by cells, 1, 186
    - universe, 8, 32
  - rate of gas, 6, 16
- Excelsin**, 10, 432
- Exchange**,
  - ion, 10, 289–300
  - reactions, 10, 19, 60–66
- Excitation**, vibrational in flames, 8, 468–469
- Exhaustion of Crookes' tubes**, 4, 489–490
- Exhibition 1851**, 1, 34–41, 65, 413
- Expanding wire detector**, 4, 333, 341
- Expansion**,
  - adiabatic, 6, 383
    - contraction, sound from, 1, 107–110
  - cooling, by, 4, 457, 8, 254–255
  - dielectrics in electric field, of, 3, 480
  - iron in magnetic field, of, 1, 523–528
  - rubber by cooling, of, 8, 254–255
  - thermal,
    - crystal structure, and, 8, 382
    - refractive index, 1, 299
    - X-ray diffraction, 9, 258
  - air, of, 4, 3
    - coefficient, 4, 462–463



**Expansion—cont.****thermal—cont.****coefficient—cont.**

ice, of, 6, 3

liquid carbon dioxide, of, 6, 5

low temperature, at, 6, 1-9

solid carbon dioxide, of, 6, 5

solids, of, 6, 5-6

crystals, of, 1, 297

gases, of, 2, 343; 4, 105-106

hydrogen, of, 4, 467

Expedition to eclipse at Oran, 2,  
254-255

Expiration of carbon dioxide, 1, 378

Experiment, Stern-Gerlach, 9, 90-92

Experiments in sound, 2, 22-30

**Exploding,**

atoms, 7, 501-511

gold wire, 3, 94

platinum wire, 3, 94

Explosion, 6, 299-313; 8, 462-488

azides, of, 7, 201

carbon,

dioxide-hydrogen-oxygen mixture,  
1, 128

monosulphide, 7, 150

monoxide-oxygen mixture, 6, 301

coal mines, in, 3, 156; 4, 142-144;  
6, 299

cordite, 7, 29

duration of luminosity, 6, 301

front,

radiation from, 3, 440-443

temperature, 3, 443

gas pressures, 7, 29

high pressure, at, 6, 312

hydrogen,

air mixture, 8, 469-470

chlorine mixture, 1, 415

oxygen mixture, 2, 422-423

hydroxylation in, 6, 303

kinetics, 4, 142-149

limits, 9, 466-467

methane-air mixture, 8, 469-470

motive power, from, 4, 142

nitric oxide-carbon disulphide

mixture, 2, 19

photography, 9, 465-494

rate of propagation, 3, 440

spectra, 3, 446-447

temperature, 3, 380-386

**Explosion—cont.****temperature—cont.**

and pressure, 3, 449-450

traces of metals in, 3, 442-450

wave, 4, 143; 9, 469-494

definition, 6, 300

velocity, 6, 301

Explosive, 9, 103, 248

gas, radiation detector, 4, 341

mixture, 6, 299

Extensibility of bubble columns, 8,  
162-166

Extinction of flames, 6, 299

phosphorous glow, 2, 209; 4, 15; 9,  
27

Extra current, 2, 58-67

Extraction of colours from flowers, 10,  
112-114

Extraction of perfumes, 6, 11

Extraordinary ray, 9, 547-550

Extrapolation, 5, 237

**Eye,**

beetle, of, 4, 186

disease, 10, 237

electric pulse from, 5, 419

focusing, 5, 278

imperfections, 6, 125

radiation detector, 4, 341

radium, action of, 6, 49

selenium model, 2, 475-477

sensitivity, 8, 237

theory, 4, 339-440

transmission of infrared, 1, 530

ultraviolet absorption, 3, 264

Young's work, 5, 278

Eyelashes, 6, 130

**F**

F-centres, 5, 37

F, low, 8, 205-207

Fabrics, sound transmission, 8, 369

Face-centred-cube, 7, 338, 347, 450

**Faces,**

primary, 7, 334

real vertical, 7, 350

**Facettes,**

crystal, 1, 294-304

of glass, 5, 395

**Facettes—*cont.***

- plagial of quartz, 1, 7
- Falling stream, 6, 72-73
- Fan electric, 4, 89-90
- Far infrared,
  - wavelength, 9, 224
  - waves, 7, 487
- Far ultraviolet, 7, 487-491
  - calcined, 3, 170
- Farad, 3, 94
- Faraday,
  - ancestry, 2, 114
  - Anderson, and, 2, 57
  - apprenticed bookbinder, 9, 93-94
  - bookseller, as, 2, 51 53
  - cage effect, 1, 43-44; 4, 93, 113-123
  - character, 2, 65-67, 113-123
  - chemical papers, early, 2, 54
  - childhood, 9, 93
  - chromatopa, invention of, 2, 57
  - conductors and insulators, view on, 2, 78-82
  - dark space, 9, 123
  - Davy, relationship with, 2, 51-53; 9, 95
  - death, 9, 93
  - de la Rive, and, 2, 52 54
  - diamagnetism, definition of, 2, 88-93
  - diary, 9, 387
  - discoveries, 2, 50 123
    - benzene, 2, 56; 4, 157; 9, 98-100
    - capacitance, 2, 78-82
    - carbon tetra chloride, 4, 157
    - chlorine, 2, 55
    - diamagnetism, 2, 88-93
    - eddy currents, 2, 58-67
    - electric permittivity, 2, 78 82
    - glass colour changes, 2, 56
    - hexachlorobenzene, 9, 96
    - hexachloroethane, 9, 96
    - magneto-optical effects, 2, 84-88
    - tetrachloroethylene, 9, 96
  - distance, view on action at a, 2, 79
  - effect (*see magneto-optical effect*)
  - electrochemical terms, definition of, 2, 73
  - Encyclopedia Britannica, use of, 2, 52
  - Europe, travel in, 2, 52
  - first contribution to science, 2, 53
  - glass in eyes, 2, 56
  - gravity, view on, 2, 79

**Faraday—*cont.***

- ideas on lecturing, 9, 94
- income, 2, 116-117
- laws of electrolysis, 1, 137-139, 164-172, 365; 2, 73-75; 5, 404; 9, 397-405
  - in flames, 7, 4
- lectures to children, 9, 106
- life, 2, 50-123; 4, 150-151; 7, 235; 9, 93-95, 386-390
- lines of force, invention of, 2, 101-107
- lone worker, 9, 105
- Lord Melbourne, and, 2, 120
- Marcott, Mrs. and, 2, 51-53
- marriage, 2, 54, 114
- mathematics, and, 4, 156
- offered presidency of R.I., 2, 117
- paramagnetism, definition of, 2, 88-93
- Peel, and, 2, 119
- Pepys, referred to by, 2, 51-52
- religion, 2, 115
- researches, early, 2, 54
- resident at R.I. 2, 54
- R.I. and, 2, 50-123; 4, 150-151; 9, 93-95
- Rome, in, 2, 53
- scientific philosophy, 2, 65
- summary of work, 2, 112-113
- Switzerland, in, 2, 82-83
- the, 2, 62-72
- theoretical work, 9, 106-107
- theory of,
  - electricity, 2, 107-172; 4, 154
  - electrolysis, 8, 343-344
  - electromagnetism, 9, 106-107
  - magnetism, 2, 101-107
  - Tyndall, and, 2, 53
  - letters to, 2, 115-116, 121
- Vesuvius, visit to, 9, 95
- wide interest, 9, 105-106
- work on,
  - acoustics, 2, 57; 4, 155
  - alloys, 2, 55; 4, 158; 9, 97
  - atmospheric magnetism, 2, 96-101
  - catalysis by platinum, 2, 72; 9, 396
  - chemistry, 4, 157-166; 9, 93-108
  - chlorine hydrate, 2, 55; 9, 97

**Faraday—cont.****work on—cont.**

- chlorination of benzene, 9, 99
- conduction, 2, 80–82
  - of diamond, 399
- cutting instruments, 9, 97
- diamagnetism, 4, 154
- eddy currents, 2, 89–90
- electricity,
  - frictional, 2, 78–82
  - identity of types of, 2, 67–72
  - intensity of, 2, 67–72
  - quantity of, 2, 67–72
- electrochemical equivalent, 9, 107, 401
- electrochemical measurement, 2, 73–75
- electrochemistry, 2, 67–78; 9, 107, 386–410
- electrolysis, 5, 483
  - of water, 2, 72
- electrolytic conduction, 9, 394–397
- electromagnetic induction, 2, 58–67; 3, 300–301; 4, 151–154
  - terrestrial, 2, 58–67
- electromagnetism, 2, 58–67; 3, 270
- electrostatics, 2, 78–82
- extra current, 2, 58–67 *f*
- firefly, 9, 95
- fused salts, 9, 396–400
- glass, 2, 56–57; 4, 158; 9, 104
- glow-worm, 9, 95
- gold films, 4, 160; 9, 104
- hydrogen-oxygen blowpipe, 9, 96
- ice, 4, 158
- iodine, 9, 94
- lead-glass, 9, 104
- liquefaction of,
  - chlorine, 2, 55–56; 4, 158; 9, 97–98
  - gases, 2, 55–56; 5, 361; 9, 97–98
- low temperature, 4, 160
- magne-crystals, 2, 88–96
- magnetism, 2, 96–101; 9, 135–136
  - of gases, 2, 96–101
- magneto-optical effect, 2, 454–467; 4, 155
- manufacture of optical glass, 2, 56–57
- mercury vapourisation, 2, 55–56

**Faraday—cont.****work on—cont.**

- metal vapours, 2, 56
  - natural gas, 9, 95
  - nitrogen iodide, 9, 94
  - nitrogen trichloride, 9, 94
  - optical properties of gold leaf, 4, 160
  - organic chemistry, 4, 157–158
  - oxygen-hydrogen reaction, 2, 72
  - polarised light, 2, 84–88
  - photochemistry, 2, 56
  - physics, 4, 151–156
  - razors, 9, 97
  - rusting, 9, 97
  - solidification of gases, 9, 97–98
  - sound, 2, 57; 4, 155
  - sounding flames, 2, 54
  - steel, 2, 55; 4, 158; 9, 97
  - sulphonation of naphthalene, 4, 158
  - terrestrial magnetism, 2, 96–101
  - torpedo fish, 9, 94
  - volcanic lime, 9, 86
  - Voltaic pile, 2, 79–78
  - waves, 4, 155
- Fatigue,**
- effect on muscle response, 5, 418–419
  - metal, 10, 225–226
- Fats,**
- bulk modulus, 8, 348
  - molecular structure, 9, 1–2
  - molten, 6, 11
  - refractive index, 6, 166
  - saponified, 9, 72
  - X-ray diffraction, 9, 1–2
- Fatty acids, 1, 574**
- C—C bond length, 9, 464
  - crystal structure, 9, 257
  - phosphorescence, 4, 377
  - spectra, 7, 362
  - X-ray diffraction, 9, 40–47
- Fatty oils, contraction in electric field, 3, 480**
- Fatty pigments, 10, 227–243**
- Fatty tissues, 10, 227–243**
- Faults, formation, 8, 292**
- Fauré, storage, cell, 6, 375**
- Fazelite, 1, 331**
- Feathers,**
- colour, 4, 236–240; 9, 18; 10, 236

**Feathers—*cont.***

- lutein in, 10, 236
- phosphorescence, 4, 377; 5, 464
- photographic plate, action on, 5, 259
- pigments in, 4, 236–240
- X-ray diffraction, 9, 457
- Febrifuges, 3, 369–370
- Fehlin's solution, 9, 156
- Felspar, 1, 536
  - zoned crystals, 4, 53
- Felspathic glazes, 9, 162
- Felt, coefficient of sound reflection, 8, 369
- Fenchone, 6, 12
- Fergusonite, 6, 115
- Fermat's principle, 9, 206
- Fermentation, 1, 56, 158; 6, 36–37
  - inhibition by methylation, 9, 55
- Ferments, 4, 52; 8, 27
- Ferrates, 2, 182
- Ferric (*see also iron*)
  - acid, 1, 333
  - azide, 7, 197
  - chloride,
    - colour and temperature, 4, 263
    - magnetic permeability, 5, 10
    - magnetism, 1, 191
    - test for anthcyanins, 9, 120
  - compounds, 2, 181
  - ferricyanide, 2, 47, 233–239
  - gallate, 1, 129
  - meconate, 1, 129
  - oxide, 1, 161
    - colloidal, 2, 216–217
    - colours of, 9, 161
    - in glass, 9, 160–163
    - reaction with carbon monosulphide, 7, 152
  - salts,
    - colour, 2, 182
    - use in blueprints, 4, 42
  - sulphate, 3, 285
  - sulphide, 9, 163–164
  - sulphocyanide, 1, 128
  - thiocyanate, 1, 128
- Ferricyanide, in photographic processes, 4, 42
- Ferro-magnesium minerals, 8, 111–112
- Ferrocyanide,
  - barium, 1, 162
  - potassium, 1, 191

- Ferromagnetic materials, 4, 127
- Ferromagnetism, 1, 191, 523–528; 9, 88–89
  - elongation of iron, 1, 523–528
  - sound, and, 1, 523–528
  - stress, and, 3, 18–20
  - temperature, effect of, 1, 195
- Ferrosocobaltic oxide, 3, 53†
- Ferrosoferric oxide in glass, 9, 160–163
- Ferrous (*see also iron*)
  - acetate, 5, 498
  - ammonium sulphate, 7, 351
  - carbonate, 9, 195
  - chlorate, 4, 220
  - compounds, 2, 181
  - croconate, 4, 214
  - ion, radius, 9, 86
  - oxalate, 4, 48
  - oxide, 9, 160–163
  - salts, colour, 2, 182
  - sulphate,
    - seeding, 3, 398
    - water eutectic, 2, 522
  - sulphide, 5, 498
- Fertilizers, 6, 181
- Fibre,
  - cellulose, 9, 246
  - polarisation of microwaves, 5, 23
- quartz, 3, 560–569
  - creep, 4, 368
  - oscillation properties, 4, 361
- soap, 9, 66–72
- torsion and loading, 4, 371
- Fibreglass, 3, 561–562
- Fibroin, 10, 429
  - crystal structure, 9, 475
  - in silk, 9, 455
- Field,
  - electric in atoms, 7, 502
  - electromagnetic, 4, 7–8
  - internal, 6, 162–164
  - magnetic, 4, 7–12
    - atoms, in, 7, 502
    - definition, 4, 127
    - minerals in, 8, 489–509
  - particles in, 8, 522–536
- Fiery opals, 3, 459
- Figures, lissajous, 4, 387
- Filament,
  - cathode, 7, 488
  - hardening of carbon, 8, 295

**Filament—cont.**

- lamps for film-making, 10, 133–134
- metal, 7, 47–48
- Nernst, 7, 47, 240; 9, 225
- osmium, 7, 47
- tantalum, 7, 47–53
- temperatures, 7, 46–53
- thermionic emission, 7, 493

**Film,**

- black,
  - diffusion through, 8, 173–176
  - plane, 8, 136–142
- bursting, 8, 6
- collodion, of, 8, 1–6
- compression, 9, 110–111
- contours, shadows of, 8, 158–159
- fourth state of matter, 9, 109
- gold, of, 9, 104
- high-speed, 10, 11
- iodide on silver, 3, 238
- liquid, 3, 318–324; 8, 136–178; 10, 446–457
  - colours, 8, 123–126
  - limiting thickness, 3, 234–237
- lubrication, 9, 109
- making, 10, 133–134
- measurement of thickness, 9, 40
- metal, 3, 239
  - electron diffraction, 9, 190–192, 208–210, 360
- microscopic examination, 8, 4–6
- natural, 9, 109
- nickel, 6, 382
- oil, of, 9, 109
  - thickness, 4, 30–31
- oleic acid, of, 9, 40
- oxide, of, 5, 56
  - copper, on, 3, 238
  - steel, on, 3, 237–238
- protein, 10, 414–427
- silver, filters, 7, 211
- soap, 9, 109; 10, 446–457
  - electric current, effect of, 3, 323
  - gas viscosity, and, 8, 443–448
  - horizontal, 8, 436–443
  - in vacuo, 8, 6–22
  - production, 8, 391
  - resistance, 3, 317–324
  - thinning, 3, 319–324
  - spreading, 10, 417–427
- sputtered, 9, 362

**Film—cont.**

- structure, 9, 37–47
  - thin, 9, 109–113
  - water, on, 9, 110–113
  - X-ray diffraction, 9, 37–47
- Filter,**
- iodine, 1, 532
  - light, 5, 253–254
  - silver film, 7, 211
  - sodium bichromate, 4, 243
- Filtering of air,** 8, 311–312
- Filtering gold sols,** 1, 250
- Fine lint,** 2, 277
- Fir charcoal,** 6, 106
- Fire-brick,**
- combustion catalysis, 7, 411–430
  - softening-point, 7, 237
- Fire-clay combustion catalysis,** 7, 406
- in furnaces,** 7, 239
- Fire colour and temperature,** 7, 238
- Fire-damp,** 4, 142, 144; 6, 279
- Fire-jacket,** 2, 308
- Firefly,** 4, 375; 9, 218
- chemiluminescence, 4, 507
  - studied by Faraday, 9, 95
- Fireplaces,** 2, 276
- Firing of furnaces,** 3, 389–390
- Firmness of sand,** 3, 356
- First,**
- difference tone, 4, 385–493
  - law of thermodynamics, 4, 275; 6, 363
  - mean line, 1, 298–304
  - order decay, 7, 248
  - summation tone, 4, 385–393
- Fish,**
- chemiluminescence, 4, 507; 9, 218
  - electric discharge from, 9, 94
  - killed by ultrasonics, 9, 292–296
  - liver oil, 8, 375
  - net hypothesis, 8, 108–109
- Fission nuclear,** 9, 13–16
- Fits, theory of,** 8, 513–514
- Fitzgerald-Lorentz contraction,** 8, 213
- Five fundamental angles,** 7, 351
- Fixer, sodium thiosulphate,** 4, 41
- Fixers,** 4, 480
- Fixing,**
- dyes, of, 2, 506–509
  - indigo, of, 3, 168–173
  - nitrogen, of, 3, 28–29

- Fizeau's experiment, 8, 213  
 Fizeau's parabolic law, 4, 463  
 Flakiness of crystals, 9, 422-427  
 Flame,  
   acetylene, 3, 178; 5, 33  
   appearance at low pressure, 1, 360-364  
   arsenic, 2, 152  
   batwing, 2, 33  
   battery, 1, 113-114  
   benzene, 5, 33-34  
   blowpipe, 3, 178  
     effect on, 2, 33-35  
   calorimeter, 4, 470  
   candle, 1, 277, 318; 2, 152  
     introduction of air into, 1, 363  
     moving, 2, 32  
   carbon,  
     disulphide-nitric oxide, 2, 152  
     disulphide-oxygen, 2, 152; 5, 30  
     monoxide,  
       moist, 3, 199-200  
       radiation from, 8, 468-469  
       under pressure, 2, 153-154; 8, 468  
     particles in, 1, 363; 2, 152  
   cause of luminosity, 1, 363; 2, 151-155; 5, 27-35  
   coal-gas, 3, 180  
     spectrum, 3, 199-200, 205  
   conduction, 1, 111-114, 334-337; 7, 1-4  
   cooling, effect of, 6, 310-311  
   cyanogen,  
     moist, 5, 35  
     nitric oxide, 3, 180  
     radiation from, 5, 35  
     spectrum, 3, 174-186  
   Davy's definition, 6, 299  
   definition, 6, 299; 9, 465  
   detonation, 4, 143-144  
   diffusion of water vapour in, 5, 198  
   discharge between, 7, 1-2  
   electrical neutralisation by, 1, 264  
   electrical properties, 7, 1-4  
   electrons in, 7, 4  
   ethylene, 3, 174  
   extinction, 6, 299  
   Faraday's laws in, 7, 4  
   fish-tail, 2, 31  
   Flame—*cont.*  
     flaring, 2, 31  
     fluttering, 2, 31  
     front, vibrations, 4, 143-144  
     gas, 3, 142  
     hydrocarbon,  
       light emission, 5, 32-34  
       spectra, 3, 174-186  
     hydrogen, 2, 148-150  
       carbon monoxide, effect of, 8, 471-473  
       light emission, 1, 494; 8, 448-488  
       spectrum, 3, 199-200  
       under pressure, 2, 153  
     hydroxylation in, 6, 303  
     infrared emission, 9, 228  
     ions in, 7, 1  
     length, 3, 387  
     luminosity, 6, 300  
       and solid matter, 5, 29-35  
       source of, 1, 363; 2, 151-155; 5, 27-35  
     luminous, 2, 151-155; 5, 27-35  
     magnesium, 3, 186-199  
     musical box, effect on, 2, 37  
     oxygen atoms in, 8, 473-475  
     Ohm's law in, 7, 3  
     phosphine, 5, 31-32  
     phosphorous, 2, 152; 5, 30  
       chlorine, 2, 154-155  
     photography, 9, 465-494  
     production of electricity in, 1, 113-114  
     reaction mechanism, 4, 147-149  
     roar in chimney, 2, 32  
     salt on conductivity, effect on, 7, 3  
     shock waves in, 9, 479  
     sound,  
       effect on, 2, 31-37  
       from, 3, 47  
       moving, 2, 32  
       -sensitise, 2, 31-37, 414-419; 3, 455-465; 5, 476-482; 5, 197-200; 6, 56  
     spark, 7, 239  
     spin, 9, 481-493  
     spectra, 8, 370  
       under pressure, 2, 153-154  
     spectrum-reversal, 1, 388-389  
     stationary, 9, 465-466  
     stroboscopic viewing, 2, 32-33

**Flame—cont.**

- studied by Faraday, 2, 54
- temperature, 1, 432; 7, 237
- variation with pressure, 1, 363
- tube in, 2, 32
- Tyndall's work, 4, 278
- ultraviolet spectra, 3, 260–261
- velocity, 4, 142–149; 7, 409; 8, 469; 9, 467–494
  - and photography, 4, 143
  - vibrating, 2, 32–33; 6, 300
  - vibrational excitation in, 8, 468–469
  - violin, effect on, 2, 35–36
  - voltage-current relationship, 7, 2
- Flameless combustion, 7, 408–409
- Flash-light, magnesium, 4, 58
- Flasks, (vacuum *see Dewar vessels*)
- Flatness of water surface, 4, 244
  - standard, 4, 243
  - test for, 4, 242–247
- Flats, optical, 5, 392
- Flattening of glass, 4, 244–247
- Flavanols, 9, 116
- Flavanthrene, 5, 537
- Flavone,
  - chlorides, 9, 117–118
  - structural formula, 9, 116
  - hydroxylated, 9, 116
- Flavopurpurin, 3, 172, 368
- Flavoxanthin,
  - chromatography, 10, 231
  - occurrence, 10, 234–235
- Flavylium salts, 9, 119–120
- Fleming cymometer, 8, 201
- Flesh, X-ray transparency, 4, 486
- Fleur de garance, 2, 243
- Flexibility, 8, 346
- Flight, 5, 294–295
  - of golf ball, 7, 104–119
- Flinder's bar, 3, 19
- Flint, 7, 54
  - glass, 5, 254
    - dense, 9, 161
    - dispersion, 3, 254–246
    - ferric oxide in, 9, 161
    - light, 9, 161
    - magneto-optical effects, 3, 516, 532–533
  - ground, 7, 31
  - occurrence, 2, 383–384
- Floating by surface tension, 3, 333–337

**Flocculation by ultrasonics, 9, 292**

- Flour,
  - bleaching, 7, 368
  - colour, 7, 368
- Flow,
  - graphite, of, 7, 27
  - metals, of, 6, 7
  - pressure changes in, 7, 432–436
  - through tube, 6, 68
  - water, of, 3, 295–297
- Flower,
  - basket, Venus', 7, 63
  - colour, 9, 18–25, 114–121
    - and sap pH, 9, 115
  - extraction of, 10, 112–114
  - ice, 10, 380
  - phosphorescence, 4, 377; 5, 464
  - plastid pigments in, 10, 227
- Fluctuations,
  - density, in, 9, 273–276
  - dielectric constant, in, 9, 273
- Flues, 2, 421
- Fluid,
  - electric, 4, 154
  - magnetic, 1, 140
  - motion, 2, 510–517; 3, 290–299; 4, 248–257; 7, 431–444
    - (*see also hydrodynamics*)
  - of perfect, 5, 215–232
  - state, 4, 104
  - theory, 2, 510–511
  - viscosity, 3, 290–299
- Fluocerite, 3, 410
- Fluorapatite, 5, 84
- Fluorescein, 1, 225; 4, 508; 6, 99
  - fluorescence, 10, 120
  - potassium salts, 6, 99
  - sensitisation, 9, 220
- Fluorescence, 1, 309–313
  - aesculin, of, 1, 489
  - azo-dyes, of, 2, 191
  - crystals, of, 1, 298–304
  - datura stramonium, of, 1, 88
  - definition, 3, 253
  - duration, 3, 253–254
  - eosin, of, 7, 81; 9, 277
  - fraxin, of, 1, 489
  - gums, of, 4, 491
  - mercury vapour, of, 7, 207, 217–220
  - model of, 3, 250–254
  - organic compounds, of, 1, 484–491

**Fluorescence—*cont.***

- phosphorescence, and, 3, 253
- demonstration of difference to, 4, 508
- quinine, 1, 88, 310
  - sulphate, 1, 258
- rhodanin, 7, 206
- sodium, 10, 387–389
- spectra, 1, 489–491
- Stocke's law, 9, 184
- Stokes theory, 3, 250–254
- theory, 1, 495–496; 3, 250–254
- ultraviolet, 1, 427
- uranium glass, 1, 310; 3, 252
- salts, 1, 88
- X-ray, 4, 485; 7, 344; 8, 58
- Fluorescent screen, 3, 257
- for X-ray diffraction, 7, 353
- Fluorides,
  - action of chlorine, 5, 88
  - compared to chlorides, 5, 84
  - electrolysis, 5, 87, 89
- Fluorine, 5, 84–98
  - abundance, 10, 272
  - applications, 5, 97–98
  - atomic,
    - heat, 7, 401
    - radius, 8, 326
    - refraction, 2, 541; 4, 478
    - volume, 7, 337, 401
    - weight, 1, 501–508; 2, 541; 4, 477; 8, 340
  - boiling point, 5, 466
  - chemical reactivity, 5, 95–97
    - of liquid, 5, 466; 6, 425
  - compounds, boiling points, 5, 465
  - copper apparatus, use of, 5, 96
  - critical pressure, 4, 478
  - density of liquid, 5, 466
  - discovery, 2, 315–316; 5, 95
  - glass, in 5, 445
  - ionic radius, 9, 80
  - isolation, 5, 95
    - attempts at, 5, 87–93
  - isotopes, 8, 339–340
  - liquefaction, 4, 477–478; 5, 415–416
  - liquid, 5, 95–97, 466; 6, 425
  - magnetism, 4, 221; 5, 466
  - mass spectrum, 8, 339–340
  - nuclear fission, 9, 13–16
  - occurrence, 5, 84

**Fluorine—*cont.***

- radioactive, 10, 110–111
- solid, 6, 424–425
  - reaction with liquid hydrogen, 6, 424
- sulphur, action on, 5, 95
- surface tension of liquid, 5, 466
- Fluorite prism, 9, 225
- Fluorochlorides, 5, 88
- Fluorspar, 1, 303
  - calcium fluoride, 5, 84
  - cleavage, 4, 120
  - crystal structure, 8, 318–323
  - fluorescence, 4, 507
  - free calcium in, 9, 166
  - heat, effect of, 9, 165
  - phosphorescence, 1, 309–310
  - sparks, effect of, 4, 508
  - thermoluminescence, 4, 507–508
  - ultraviolet transmission, 1, 430–431; 4, 328–330
- X-ray,
  - defraction, 7, 353
  - effect of, 4, 508–509
- Fluted spectra, 3, 124
- Fly-wheel, 4, 436
- Flying machine, 5, 294–295
- Foam in sea, 9, 112
- Foaming, cause of, 4, 26–28
- Focal length, 6, 125
- Focus,
  - depth of, 4, 185
  - tube, 4, 506
- Focusing,
  - electrons, of, 5, 99–100
  - eye, of, 5, 278
  - Hertz waves, of, 4, 347
- Fog,
  - clearing by discharge, 5, 234
  - condensation, 6, 62–66
  - signals, 5, 478–479
- Foil, metal, 9, 2
- Fontainebleau calcite, 4, 55
- Food,
  - carotenoids in, 10, 235–243
  - for cattle, 8, 376
  - vacuoles, 8, 31
- Foot,
  - caterpillar, 4, 186
  - spider, 4, 186
- Force, 1, 413–421



- Force**—*cont.*  
 attractive, 2, 158; 3, 325  
   between metals, 5, 68–71  
 annihilation of, 1, 230–240  
 centrifugal, 5, 278  
 chemical, 1, 4–8, 18, 136–139, 236, 373–380  
   contact-, 1, 18  
 coercive, 10, 459  
 conductor, on, 3, 216  
 conservation of, 1, 227–240  
   in nature, 1, 370–380  
 electric, 1, 61, 227–240  
 electromotive, 1, 365–369; 4, 86  
   origin, 5, 563  
 gravitational, 1, 64, 227–240, 413; 3, 325  
 intensity of, 1, 370  
 interatomic, 9, 79  
 intermolecular, 4, 266; 10, 1–2  
   demonstration of, 3, 328–330  
   gases, in, 4, 4  
   range, 3, 327  
   repulsive, 3, 132–133  
 internuclear, 9, 8–10, 73–76  
 lines of, 1, 227–240; 2, 101–107, 372–382; 4, 7–12  
   curvature, 1, 59–63  
   electrical, 2, 268–269; 4, 95  
   magnetic, 9, 139  
 magnetic, 1, 9, 11, 25–28, 59–73, 140–153, 188–195, 227–240  
   on electric discharges, 1, 314–318  
 magnetomotive, 4, 87  
 measurement of small, 3, 560–569  
 moon, on, 6, 289  
 nature of, 1, 227–240  
 pound, 4, 428  
 theory, 1, 227–240  
 time, and, 1, 228  
 unit, 4, 428  
 vital, 1, 270–276
- Forced vibrations**, 5, 278
- Formaldehyde**,  
 decomposition, 6, 304  
 dyeing, in, 9, 23  
 ethane flame, in, 6, 303  
 ethylene flame, in, 6, 303  
 formula, 1, 546–547; 2, 196  
 photosynthesis, 9, 194  
 pyrogallol oxidation, 9, 219
- Formamide**, 1, 452  
   infrared transmission, 8, 287
- Formation**,  
 eddies, of, 3, 296  
 faults, of, 8, 292  
 heats of for crystals, 9, 79
- Formic acid**, 1, 155, 479; 2, 387  
 colligative properties, 7, 14  
 diffusion through rubber, 7, 485  
 ethane flame, in, 6, 303  
 ethylene flame, in, 6, 303  
 infrared transmission, 8, 287  
 oxidation, 1, 142  
 silicon analogue, 2, 387  
 synthesis, 1, 142, 273, 477–480  
 viscosity, 5, 142–154
- Formyl radical**, 1, 155
- Forsterite**, 7, 130–133
- Forth bridge**, 5, 448
- Fossil ammonites**, 4, 186
- Fossils**, 10, 157
- Fountain, charged water drops from**,  
 1, 171  
   effect, 10, 465–468
- Fourth power law**, 8, 291–292
- Fourth state of matter**, 1, 281; 5, 551
- Fraction**,  
 molar, 7, 13  
 shear, by, 8, 362
- Fractional diffusion**, 10, 68–69
- Fractional distillation**,  
 hydrogen, of, 10, 18  
 mercury, of, 8, 339
- Fractionation of particle size**, 7, 174
- Frames for bubbles**, 8, 159–162
- Franklin's kite experiment**, 1, 334
- Fraunhofer's lines**, 1, 357–358, 385–389, 432; 2, 164; 3, 63, 179, 260–262  
   intensity, 8, 242
- Fraxin**, 1, 489
- Frazer high-speed camera**, 9, 474–475
- Free**,  
 energy, 6, 361–366  
 path, mean, 7, 169–171  
 radicals, 10, 65
- Freedom, degrees of**, 5, 332
- Freezing**,  
 effect of pressure, 1, 181; 7, 17–19  
 machines, 4, 457  
 mixture, 3, 23

**Freezing—*cont.*****point,**

- impurity, and, 7, 17,
- pressure, 1, 181; 7, 17–19
- vapour pressure, 7, 8–9
- depression, 2, 523; 5, 494
- colloids, of, 9, 64–67
- soap solutions, of, 9, 64–67
- theory, 7, 8

**maximum, 7, 26****salt solutions, of, 2, 520–527****volume change, 7, 17****French horn, 8, 207****Frequency,**

- atomic vibrations, of, 7, 509–511
- audible, 7, 266
- dielectric constant, and, 9, 429–430
- electrical oscillation, of, 3, 485
- high, 7, 266–293
- LC circuit, of, 5, 503
- mains, of, 7, 266
- measurement for  $\gamma$ -rays, 9, 12–13
- motion, effect of, 4, 196
- mutual induction, 3, 304
- nuclear vibrations, of, 9, 12–13
- orbital revolution, of, 8, 224
- screening, 4, 98–99
- superconductivity, 9, 429–445
- vibrating string, of, 2, 28–30
- wavelength of light, 3, 229

**Fresnel's equations, 8, 275–283****Friability, 8, 361–362****Friction and heat, 1, 196; 2, 276–281**

- internal, 6, 98
- iron, of, 4, 3
- lack of in aether, 4, 196
- mercury, of, 4, 3
- skin, 7, 436
- water in tubes, of, 4, 2–3

**Frictional electricity, 1, 261; 5, 560****Frictionless hydrodynamics, 7, 431–432****Frogs,**

- heart, 9, 294
- leg, 4, 341
- muscle, 4, 334; 5, 423

**Froth, 4, 26–38****Froude's principle, 2, 292–293****Fructose, 1, 271; 9, 50**

- photosynthesis, 9, 193–200
- structure, 6, 38
- synthesis, 1, 274

**Fruits,**

- colours, 9, 114–121
- plastid pigments in, 10, 227

**Fucoxanthin, 10, 228–231****chromatography, 10, 231****Fucus vesiculosus, 10, 228****Fuel, 9, 103–104**

- economy, 2, 276
- oil form coal, 9, 340

**Fuller's earth, 10, 291****Fulminate of mercury, 8, 297****Fulminic acid, 7, 203****Function, wave, 9, 202–204****Fundamental crystal angles, 7, 351****series, 8, 35–36****Fur,**

- heat insulation, 2, 277
- water absorption, 2, 278

**Furfural,**

- infrared transmission, 8, 288
- refractive index, 2, 544–545

**Furnace, 2, 421; 3, 377–393****annealing, 7, 419**

- electric, 7, 55–56, 239–246
- temperature, 7, 239

**forging, 7, 419****induction, 7, 239****kitchen, 2, 276****regenerative, 3, 377****reverberatory, 3, 563****Fuse,**

- Abel's, 4, 332
- blowing, 4, 330
- Statham's, 1, 97, 106

**Fused quartz, 6, 22****infrared transmission, 8, 273****Fused salts, conduction, 9, 396–400****Fusible metal (*see also Wood's metal*)**

- action on photographic plate, 5, 258
- thermal conductivity, 6, 213

**Fusion calorimetry, 6, 74****ammonium nitrate, of, 1, 50****ice, latent heat, of, 1, 253–254****wire by electricity, of, 1, 366****G****Gadolinia, 3, 414****Gadolinite, 3, 405, 410**

- Gadolinium**,  
 atomic spectrum, 3, 414  
 weight, 1, 500-508
- Gaede pump**, 9, 235
- Galactose**, 6, 38
- Galena**,  
 cleavage, 4, 120  
 crystal structure, 8, 321  
 X-ray diffraction, 7, 353
- Gallery, whispering**, 6, 60-61
- Gallilean telescope**, 1, 261-262
- Gallirex**, 4, 237
- Gallium**,  
 atomic heat, 7, 401  
 atomic volume, 7, 401  
 superconductivity, 9, 424
- Galvanic cell**,  
 demonstration, 5, 53-55  
 discovery, 5, 53  
 Helmholtz's work, 4, 394
- Galvanometer**, 3, 560; 4, 413-419  
 ballistic, 5, 7  
 construction, 3, 302  
 differential, 4, 519-520  
 moll, 9, 225  
 reflecting, 4, 438
- Gamboge**, 7, 164-183
- Gamma particles** (*see particles*)
- Gaps in periodic table**, 7, 452
- Garlic, oil of**, 1, 274
- Garnet**,  
 allotropy, 1, 36  
 zoned crystals, 4, 52
- Gas**,  
 absorption and density, 2, 237-239  
   liquids, 2, 200, 209  
   metals, 2, 45-49, 233-239  
   palladium, 2, 237-239  
   rubber, 2, 229-233  
   tantalum, 7, 50-51  
 adsorption on charcoal, 6, 104-119,  
   393-404; 7, 66-67  
 atmospheric, 6, 435-436  
 Bath, 5, 157-161  
 Boyle's law, 4, 105  
 burette, 1, 472  
 combustion (*see Combustion and flame*)  
 compression, 8, 347  
   demonstration, 4, 105
- Gas—cont.**  
 conduction, 1, 111-114, 279; 4,  
   288-290; 5, 510-511; 6,  
   17-23 (*see also discharge, electrical*)  
 constant from thermionic emission,  
   7, 498  
 critical point, 3, 247  
 cycle, Carnot, 6, 354  
 demonstration model of, 3, 254  
 density,  
   charcoal, in, 6, 216-218  
   measurement, 4, 397  
 diatomic, 5, 336-338;  
 diffusion, 2, 38-44, 221-233; 3, 256;  
   7, 167  
   black films, through, 8, 173-176  
   soap-bubbles, through, 8, 78-87,  
   166-173  
 discharges (*see arc and discharge, electrical*)  
 dissociation, 3, 377-393  
 distribution of velocities, 8, 353-358  
 effusion, 2, 38-44, 218-233  
 elasticity, 8, 347 •  
 electric discharge, from, 7, 402-404  
 electromagnetic discharges, 4, 287  
 electron diffraction, 9, 361  
 engine, Otto, 3, 216-217  
 evolution, 6, 16  
 expansion, 2, 343; 4, 105-106  
 explosion, 6, 299-313 (*see also Explosion*)  
   kinetics, 4, 142-149  
 flame (*see Flame*)  
 furnaces, 3, 377  
 Graham's law of diffusion of, 2, 224  
 heat of adsorption on charcoal, 6,  
   109-110  
 heating by radiation, 1, 391-392  
 high-frequency discharges, 4, 174-  
   176  
 history of study, 5, 359-368  
 illuminating, 9, 98  
 imperfect, 4, 5; 8, 347  
 inert, 5, 467-468; 7, 455-486  
   discharge through, 9, 122-130  
   production of, 6, 300  
 infrared,  
   absorption, 1, 305-308, 348-351,  
   390-392, 463; 2, 275-281

Gas—*cont.*infrared—*cont.*

emission, 1, 350

intermolecular forces in, 4, 4

ionisation, 6, 17–23; 7, 100–103

jets, liquid in, 4, 463–466

kinetic theory, 3, 38–40, 122, 132–133, 227–256; 5, 329–358; 7, 169–171; 8, 347

kinetics, 10, 384–403

laws, 4, 105; 8, 347

## light,

emission, 5, 27

scattering, 9, 272–273

lighter, 4, 342

lighting, 1, 42; 7, 46

limiting density, 5, 322

liquefaction, 2, 49, 55–56, 294–301; 3, 21–27, 312–317; 4, 160–161; 5, 359–368

Faraday's work, 4, 160–161

storage problems, 4, 223–229

liquid and, 4, 104–113

magnetic properties, 8, 433–434

susceptibilities, 9, 91–92

mantle, 6, 388–389; 7, 46

mixtures, adsorption, 6, 397–399

monatomic, 5, 353–356

moist, electrical discharge in, 3, 199–200

motion of ions in, 8, 179–180

occlusion (*see gas absorption*)

oxidation below flame temperature, 6, 299–300

perfect, 8, 347

phase reactions, 10, 384–403

catalysis by metals, 2, 72

polyatomic, 5, 337–338

pressure, 8, 347

in explosions, 7, 29

screening, effect on, 4, 177

separation, 6, 226–228

diffusion, by, 2, 228

using liquid air, 5, 155–161

shear, 8, 346

sound from, 3, 150–158

specific heats, 5, 329–358

temperature scale, 5, 202–212; 8, 347

## thermal,

conductivity, 3, 256

Gas—*cont.*thermal—*cont.*

decomposition, 2, 149

expansion, 2, 343; 4, 105–106

thermometer, 5, 202–212, 244–247; 7, 223–228; 10, 84–85

helium, 5, 319

range, 5, 327; 7, 238

transference through porous plugs, 5, 363

van der Waal's equation, 5, 563

vapour, and, 2, 49

viscosity, 2, 219–221; 3, 256; 7, 170  
measurement, 4, 454–455; 5, 249–252

soap films, and, 8, 443–448

temperature, and, 5, 248–252

work done by, 4, 111–112

Gaseous state, 2, 294–301; 4, 104–113

Gastrochemin's muscle, 5, 423

Gastropoda, 4, 240

## Gauge,

Bourdon, 6, 312

McLeod, 6, 260–261

petavel, 8, 463–465

Gear, Huygen's, 4, 152

Geiger counter, 6, 285–286

coincidences, 10, 32

Nuttall curve, 8, 112

Geissler pump, 4, 490

Gelatine, 5, 259

chromatised, 4, 42

diffusion in, 1, 395

of copper sulphate in, 5, 373–374

fraction by shear, 8, 362

gels, 10, 148

photography, in, 4, 43

infrared transmission, 8, 284

medium, 7, 84

phosphorescence, 4, 377; 5, 464; 7, 81

rigidity, 9, 176–181

coefficient, 9, 177

sols, 10, 148

spectrum, 7, 82

strain birefringence, 9, 167

water foam, 4, 27

Gels (*see also Colloids*)

definition, 10, 148

diffusion in, 2, 215–217

vapour pressure, 2, 526–527

- Gems, fluorescence, 4, 491  
 Generalised principle of relativity, 8,  
     185-197  
 Generation spontaneous, 2, 304  
 Generator,  
     effect of condenser, 4, 168  
     high frequency, 4, 167  
     microwave, 5, 14-17  
     van der Graaf, 9, 498  
 Genesis of elements, 3, 403-426  
 Geocentric universe, 8, 101  
 Geology and crystallography, 4, 50-57  
     of Alderley Edge, 2, 125  
 Geraniol, 6, 10-12  
 Geranium, 9, 114  
 Gerber method, 5, 452  
 German silver,  
     action on bacteria, 7, 86-92  
     breaking stress, 4, 267  
     lead thermocouple, 4, 538  
     resistance, 4, 231, 522-527  
     specific heat, 6, 85-87  
     thermal conductivity, 6, 213  
 Germany, dye production, 3, 173  
 Germination,  
     dark, in, 8, 375  
     heavy water, 10, 20  
 Germs, (*see also Bacteria and Virus*)  
     dust, 2, 302-303  
     space, 5, 471  
 Geryk pump, 9, 235  
 Getter, 9, 244  
 Gibb ring, 8, 13-18  
 Gibbous moon, 6, 123  
 Gibbsite, 10, 281-291  
 Girders, 8, 361  
 Glaciers, 1, 253; 10, 356-366  
 Glass,  
     16''', 5, 446  
     59''', 5, 446  
     absorption of electromagnetic  
         spectrum, 5, 370-371  
     achromatic, 5, 445  
     annealing, 7, 385  
     barium in, 5, 445  
     black, 9, 163  
     blowing, 7, 385  
     boron, 3, 220; 5, 445  
     Brewster's angle, 2, 170  
     bulk modulus, 8, 348-349  
     burning, 9, 94  
     cadmium sulphide, 9, 160  
     calcium, free, in, 9, 166  
     catalysis by, 7, 102  
     chilled, 4, 187  
     Chinese, 9, 158, 161-163  
     cobalt, 1, 220  
         absorption spectrum, 1, 222  
     coloration by radium, 5, 512, 6, 49; 9,  
         164  
     colour, 9, 155-166  
         change in sunlight, 2, 56; 9, 164  
     copper in, 9, 155-161  
     diamagnetism, 1, 67-73, 192; 2, 88-  
         93  
     Egyptian, 9, 155-157  
     elasticity, 3, 60-62  
     electrification, 4, 94; 5, 560  
         at low temperature, 6, 210-211  
     electron absorption, 5, 47, 414  
     electrostatic screening, 4, 94  
     etching by,  
         electrons, 5, 100  
         hydrofluoric acid, 1, 259  
     facets, 5, 395  
     Faraday's work, 4, 158  
     fibre, 3, 561-562  
         polariser, 5, 24  
     flattening, 4, 244-247  
     flint, 5, 254  
     fluorine in, 5, 445  
     German industry, 5, 445-447  
     gold, 9, 104, 160  
         particles in, 1, 217-218  
     grinding, 5, 393  
     hydrofluoric acid, action of, 4,  
         246-247  
     infrared transmission, 8, 273, 284,  
         289-290  
     iron in, 9, 155, 160-163  
     Jena, 5, 444-447  
     jets, 8, 413-414  
     kathodoluminescence, 4, 507  
     lead, 2, 56-57; 9, 104, 132  
         ferric oxide in, 9, 161  
         Faraday effect, 2, 84-88  
     lens for microwaves, 5, 16  
     light flint, 9, 161  
     manganese, 9, 164  
     manufacture, 2, 56-57  
     microscopes, for, 5, 445

**Glass—cont.**

- non-conductor, 5, 559
- opal, 2, 22; 9, 104
- optical, 2, 56–57; 5, 444–445; 9, 104
  - and infrared properties, 1, 427
- organic, 4, 263
- penetration by  $\beta$ -rays, 5, 414
- phosphoric acid, 9, 162
  - coated, 6, 21
- pitting, 5, 393
- plate,
  - effect on Hertz waves, 4, 346
  - polariser, 3, 519
- polishing, 5, 392–403
- porphyrised copper, coated with, 4, 336
- potassium in, 5, 445
- pressure under, 4, 187
- powdered, absorption, 5, 253
- purpled window, 9, 164
- radioluminescence, 5, 513; 6, 41
- reflection of Hertz waves, 4, 346
- refractive index, 5, 444–445
  - in microwave, 5, 19
- resistance and temperature, 4, 535; 5, 459
- rod, torsion, 3, 60–62
- rubies, 4, 487
- seeding by, 3, 398–399
- selenium, 9, 160
- silicates in, 7, 57
- silvering, 1, 214–215
- spin, 3, 561–562
- strain birefringence, 7, 329
  - in microwave, 5, 23
- sunlight, effect of, 2, 56; 9, 164
- tesla coil effects, 4, 171
- thermoluminescence, 5, 513
- thermometer, 5, 450
  - for, 5, 445–446
- Thuringen, 5, 446
- total internal reflection of micro-waves, 5, 18
- transmission of radioactivity, 5, 508
- tube, sound from hot, 3, 3–4
- ultraviolet absorption, 1, 88–89, 430–431; 4, 328–330; 7, 213
  - coloration, 9, 164
- uranium, 1, 310
- vessels, standardisation, 5, 452

**Glass—cont.**

- viscosity, 6, 73
  - wetting of, 3, 346–347
  - window, 7, 357; 9, 157
  - yellow bohemian, 3, 253
  - X-ray,
    - absorption, 4, 487
    - coloration, 9, 164
- Glaze,**
- Chinese, 9, 158, 161–163
  - copper oxide in, 9, 158
  - colours of, 9, 155–166
  - felspathic, 9, 162
- Glauberite,** optical properties, 1, 301
- Glauber's salt,**
- diffusion in liquids, 1, 393–396
  - water, 2, 213–215
  - supersaturation 3, 394 399
- Gliadin,** 10, 431
- Glischrometer,** 5, 137–140
- Globular proteins,** 10, 429
- Globulins,** 10, 429
- Glow,**
- discharge, 1, 277–281, 316–318; 4, 282–290 (*see also Discharge, electric*)
    - Doppler effect in, 9, 126
    - in inert gases, 5, 468; 9, 122–130
    - resistance, 3, 113–115, 226
    - striations, 3, 115–120
  - negative, 9, 122–123
    - effect of magnetic field, 1, 315
    - passage down tube, 4, 283
    - of phosphorous, 4, 13–7; 9, 26–37, 218–219, 234–235
  - worms, 4, 375
    - chemiluminescence, 4, 507
    - study by Faraday, 9, 95
- Glower, Nernst** (*see Filament, Nernst*)
- Glowing wood,** action of liquid oxygen, 4, 233
- Glucina,** 3, 408–409
- Glucinium,** 3, 407–408
- Gluconic,**
- acid, 7, 382; 9, 198
  - lactone, 7, 382
- Glucosan,** 9, 56, 60
- polymerisation, 9, 60
  - preparation, 9, 60
  - properties, 9, 60
  - structural formula, 9, 60

- Glucose, 2, 243  
 cellulose, from, 9, 59  
 Fehlin's test, 9, 156  
 formula, 9, 50  
 hydrate, 7, 382  
 methylated, taste, 9, 55  
 methylation, 9, 53-55  
   inhibition of fermentation by, 9, 55  
 mutarotation, 7, 381-384  
 pelargonin, in, 10, 115-116  
 photography, effect in, 4, 48  
 photosynthesis, 9, 193-200  
 reduction by, 9, 52  
   copper sulphate, 9, 156  
 structure, 6, 38; 9, 52  
 structural formula, 9, 246  
 zymase fermentation, 6, 37
- Glucosides, 9, 50, 55-58  
 general formula, 9, 56  
 pigment, 9, 114  
 structure, 10, 116
- Glue in hydrazine production, 7, 196
- Glue-water foam, 4, 27
- Glycerine, 1, 274-275; 3, 370; 9, 455  
 diffusion through rubber, 7, 485-486  
 films, 2, 235  
 infrared transmission, 8, 286  
 phosphorescence, 4, 377; 5, 464; 7, 81  
 soap,  
   bubbles, 8, 71-79  
   solutions, 8, 388-448  
   surface tension, 8, 389-390  
   viscosity, 8, 390-391  
 solution, 3, 319  
 spectrum, 7, 82  
 synthesis, 1, 271, 482  
 viscosity, 9, 178
- Glycocoll, 1, 482
- Glycogen, 9, 50  
 formula, 9, 246  
 phosphorescence, 4, 377
- Glycol,  
 biological oxidation, 3, 549  
 diacetate, 8, 287  
 succinic acid polymerisation, 10, 268-269
- Glycolic acid, 3, 553  
 formula, 1, 541-542
- Glyoxal, 3, 554
- Glyoxal—*cont.*  
 colour, 9, 19
- Glyoxylic acid, 3, 554
- Goitre, 10, 341
- Gold,  
 abundance, 10, 272  
 action current, 5, 427-438  
   on bacteria, 7, 86-92  
 atomic,  
   heat, 5, 190-194; 7, 401  
 refraction, 2, 541  
   volume, 7, 401  
   weight, 1, 500-509; 2, 325, 541; 5, 190  
 beaters skin, 5, 260; 8, 284  
 bismuth alloy, 9, 424  
 breaking stress, 4, 267  
 bromide, 1, 129  
 chloride,  
   invisible ink, in, 2, 425  
   reaction with zinc, 2, 337-338  
 collision with  $\alpha$ -particle, 8, 245-247  
 colloidal (*see Gold sols*)  
 combustion catalysis, 7, 406  
 conductance (*see Gold, resistance*)  
 crystal structure, 8, 320; 9, 210  
 crystallisation, 2, 335-341  
 divided, 1, 215-218, 249-251  
   in glass, 1, 217-218  
 electrode, 8, 345  
 electron absorption, 5, 47  
   density, 5, 412  
   diffraction, 9, 208-210  
 extraction, 6, 273  
 films,  
 Faraday's work, 9, 104  
 on glass, 1, 216, 249-251  
 transparency, 9, 104  
 fluorine preparation, attacked in, 5, 88  
 foil, 3, 239  
   crystal structure, 9, 2  
   electroscope, 1, 263; 5, 50  
   heat, effect of, 1, 216, 249-251  
   light transmission, 2, 21  
   optical properties, 1, 215-218, 249-251  
   polarisation of light by, 1, 250-251  
   reflection of light by, 2, 21  
   solution by aqua regia, 2, 268

**Gold—cont.****foil—cont.**

thinning, 1, 216

glass, 9, 104, 160

jelly, in, 1, 250

**lead,**

alloy, 9, 424–425

thermocouple, 4, 538

leaf (*see gold foil*)

melting point, 5, 241; 7, 237

nuclear charge, 8, 245

radius, 9, 8–10

occlusion of gases by, 2, 47

occurrence, 2, 339

potassium chloride, 5, 491

recoil, 8, 246

resistance, 4, 524–527; 5, 457

liquid helium, in, 7, 234

low temperature, at, 4, 230

rigidity, 8, 360

scattering of  $\alpha$ -particles, 9, 9–10,  
73–74

silver alloy, 4, 525–527

sols, 1, 215–218, 249–251; 9, 104

crystal structure, 8, 320

effect of salts on, 1, 217

filtration, 1, 250

scattering of light by, 2, 21

X-ray diffraction by, 9, 67

specific heat, 2, 325; 5, 190–194

spheres, 4, 359–360

surface tension of liquid, 4, 118

synthesis, 10, 253

tin alloy, 9, 424–425

tree, 2, 337–338

ultraviolet absorption, 3, 262

vessels, 5, 88

wire, exploding, 3, 94

X-ray absorption, 8, 46–54

Young's modulus, 8, 354–355

zinc couple, 2, 497

**Goldfish, 10, 236****Goldstein's double cathode, 6, 320–322****Golf-ball dynamics, 7, 104–119****Goniometer, 5, 539**

two-circle, 7, 352

**Goniometric analysis, 7, 356**

measurements, 7, 325

**Gossamer, 6, 120****Government grant, 4, 4****Graham, 2, 200–239**

character, 2, 201

D.C.L. (Oxon), 2, 205

definition of,

colloids, 2, 215

crystalloids, 2, 215

peptous and peptic colloids, 2,  
216–217

Edinburgh, in, 2, 200–201

F.R.S., 2, 205

Glasgow, in, 2, 200–201

law, 5, 374

diffusion, of, 3, 224

effusion, of, 2, 218–219

life, 2, 200–239

London, in, 202–205

Master of the Mint, 2, 204

polybasic compounds, discovery of,  
2, 207

Royal Society, and, 2, 200–205

work on absorption of gases by  
liquids, 2, 200, 209

alcohol dehydration, 2, 209

alcoholates, 2, 209

arsenates, 2, 207–209

dialysis, 2, 215–217

diffusion through membranes, 2,  
222–233

etherification, 2, 211

gas diffusion, 2, 221–233

effusion, 2, 218–219

transpiration, 2, 219–221

heat of hydration, 2, 210–211

hydration, 2, 209–211

impurity effects, 2, 208–209

liquid diffusion, 2, 213–215

transpiration, 2, 211–213

viscosity, 2, 211–213

occlusion of gases by metals, 2,  
233–239

osmosis, 2, 217–218

phosphates, 2, 205–209

phosphine, 2, 208–209

phosphoric acids, 2, 205–209

phosphorous oxidation, 2, 209

pyrophosphates, 2, 207–209

**Grandjean's planes, 9, 546****Grain, photographic, 8, 237****Gramineae, 7, 61****Gramme, 4, 429**



- Granite,**  
 graphite, in, 4, 55  
 pressure, effect of, 8, 291-292  
 temperature, effect of, 8, 291-292
- Granular materials,** 3, 350-359  
 starch, 9, 67  
 theory of the aether, 3, 350-351
- Grape,** 9, 115  
 pigment, 9, 115  
 rubidium in, 2, 320  
 sugar, 1, 271  
   mutarotation, 7, 381  
   polariscope, in, 4, 187  
   synthesis, 1, 274  
   zymase fermentation, 6, 37
- Graphic granite,** 4, 55
- Graphite,** 2, 384  
 Acheson, 7, 31  
 action on bacteria, 7, 86-92  
 C-C distance, 9, 463-464, 509-510  
 combustion in liquid oxygen, 4, 463  
 compression, 7, 33-35; 8, 303  
 Compton effect, 9, 189-190  
 crystal structure, 8, 320, 382, 9, 257, 509-510  
 Cumberland 6, 107,  
 density, 6, 6; 9, 55  
   diamond conversion, from, 5, 103;  
     8, 241  
   to, 7, 28-35  
 diffusion of gases through, 2, 42-44  
   224-229  
 distance between sheets 9, 510  
 electrode 3, 107-108  
 flow properties, 7, 27  
 furnaces, 7, 239  
 gas occlusion, 6, 78  
 heat of combustion, 9, 464  
 hydraulic fluid, as, 7, 27-29  
 insulation 5, 164  
 lubricant, as, 8, 382  
 pressure, effect of, 8, 303  
 mercury fulminate, reaction with,  
   8, 303  
 olivine, reaction with, 8, 303  
 sodium nitrate, reaction with, 8, 303  
 specific heat, 7, 233-234  
   and temperature, 6, 43, 83-85  
 spiral heater, 7, 241  
 thermal expansion, 6, 8, 382; 9, 258
- Graphitic acid,** 7, 33
- Graphitoidal silicon,** 2, 384
- Grass,**  
 carotene in, 10, 228, 235, 239-243  
 coefficient of sound reflection, 8, 369  
 xanthophyll in, 10, 228, 235
- Grating,**  
 diffraction, 3, 143, 247, 441  
 echelon, 7, 376-377  
   transmission, 10, 203  
 electric screening by, 4, 94-95  
 etching by hydrofluoric acid, 4, 246-247  
 infrared, 9, 225  
 polariser, 5, 20-22  
 sound, 3, 464-465  
 three-dimensional 7, 345
- Gravel,** coefficient of sound reflection,  
 8, 369
- Gravitation,** law of, 4, 249, 350-374; 5,  
 296
- Gravitational constant,** 4, 350-374; 5,  
 296-333; 10, 901
- Gravity,** 1, 15, 64, 70, 188; 3, 325, 350-359; 5, 296-312; 10, 99-107  
 acceleration due to, 8, 189  
 aether, and, 6, 289-296  
 Cavendish's experiment, 4, 352  
 demonstration of, 3, 568-569  
 directional, 5, 303-305  
 force of, 1, 227-240, 413; 3, 325  
   measurement, 3, 560  
 heat from, 1, 414  
 inertia, and, 1, 233-240  
 inverse square law, 4, 350  
 laws of, 4, 249, 350-374; 5, 296  
 light, and, 8, 193  
 mines, in, 4, 351  
 moon, of, 10, 99-100  
 mountain, effect of, 4, 351  
 radiation pressure, and, 6, 151  
   spherical body, 4, 350  
 relativity theory of, 8, 102-103, 181-197  
 smallness, 4, 352  
 temperature, and, 5, 311, 472  
   effect of, 5, 311, 472  
 theory of, 1, 59, 143-149; 2, 79, 372-382; 8, 102-103, 181-197  
 time, and, 1, 60
- Gray-King assay,** 9, 326-331

- Grease, effect on,  
     camphor-water, 6, 15  
     gas evolution, 6, 16  
 Great Exhibition, 1, 34-41, 65, 413  
 Green salt of Magnus, 2, 249  
 Green seedlings, 8, 375  
 Grey cast iron, 8, 508  
 Gridirons, 2, 276  
 Grignard reagents, 7, 203  
 Grilling, 7, 413  
 Grinding of glass, 5, 393  
 Grothius,  
     mechanism, 6, 92-93  
     theory of electrolysis, 5, 484  
 Ground and air temperature, 3, 275-280  
 Ground sound reflection, 8, 369  
 Group V elements, 2, 124-130  
     velocity, 9, 207  
 Groups, point, 7, 122-134  
 Grove's cell, 1, 3, 200  
 Growth, crystals, of, 1, 303  
     parallel, 7, 326-328  
     plants, of, 1, 303  
     rats, of, 8, 374  
     zonal, 7, 328  
 Guanidine, silicon, 7, 60  
 Guericke's pump, 9, 232-235  
 Guitar, 8, 211  
 Guldberg and Waage's principle, 5, 498  
 Gum,  
     acacia, 7, 484-485  
     arabic,  
         diffusion in,  
             liquids, 1, 393-396  
             water, 2, 213-215  
         viscosity, 9, 173-181  
     benzoin, 9, 99  
         cinnamic acid in, 3, 166  
     colloidal, 1, 396; 2, 216-217  
     phosphors, 6, 233  
     senegal, 3, 170  
     traganth, 3, 170  
 Gun,  
     breech-block, 8, 318  
     cotton, 7, 195  
     pressure in, 8, 296  
     rifled, 1, 117-118  
 Gunpowder,  
     Rumford's work, 2, 275  
     Gunpowder—*cont.*  
         thermodynamics, 2, 422  
 Gutta-percha, 5, 60  
     as an insulator, 1, 96-97; 5, 559  
     resistance and temperature, 4, 535; 5, 497  
     works, 1, 96  
 Gymnoschizorhis, 4, 237  
 Gypsum,  
     birefringence, 5, 549  
     optical properties, 1, 299-301  
     thixotropy, 10, 158-163  
         and ultrasonics, 10, 163  
     X-ray diffraction, 7, 353  
 Gyroscope, 1, 115-121; 3, 136  
     Kelvin's work, 6, 369  
     magneto-optics, and, 6, 371  
     ship, on, 5, 185  
     theory, 5, 184-5  
 Gyroscopic pendulum, 3, 292; 5, 187-188  
 Gyrostat, 6, 369  
 Gyrostatic medium, 5, 187-188
- ## H
- Habit, crystal, 5, 540  
 Haematin, 4, 235  
 Haematite,  
     colloidal, 1, 396  
     specular, 8, 489-509  
 Haemocyanin, 4, 240  
     molecular weight, 10, 431  
 Haemoglobin, 7, 195  
     molecular weight, 10, 431  
     structure, 4, 235  
     X-ray diffraction, 10, 432  
 Hail, 1, 344  
 Hair, 3, 561-562; 10, 429  
     chemical constitution, 9, 446-447  
     Indian bat, 4, 186  
     inertness, 9, 460  
     polarisation of microwaves, 5, 83-84  
     reindeer, 4, 186  
     stretching, 9, 457  
     structure, 9, 446-447  
     X-ray diffraction, 9, 457  
 Hand, phosphorescence, 1, 309  
 Half-bubbles, 8, 156-158  
     life and  $\alpha$ -particle velocity, 8, 521  
     lives, 6, 276-286

- Halides, reaction with sodium azide, 7, 202
- Hall effect, 6, 354  
theory, 5, 564
- Halloysite, 10, 281-290  
X-ray diffraction, 10, 290
- Halogens (*see also Fluorine, etc*)  
alkali metal chemiluminescence, 9, 220-221  
atomic refraction, 6, 163  
atomic volumes, 7, 337  
valency, 8, 117
- Haloës,  
pleochroic, 8, 128  
radioactive, 8, 111-112  
radioactive, 8, 111-112  
reversal, 8, 111-112
- Hare's fur, 2, 277
- Hardened steel, 8, 508
- Hardening of carbon filaments, 8, 295
- Hardness, 8, 346, 361-362  
alloys, of, 9, 2  
crystals, of, 7, 120, 8, 330  
facettes, of, 1, 295  
structure, and, 9, 2-3  
surface, 8, 361  
water, 2, 262-264
- Harmonic,  
analysis, 6, 372  
organ pipe, 8, 103  
stretched string, 2, 24
- Harmonographs, 3, 13
- Harmony, colour, 1, 243-245; 2, 275
- Harp, Aeolian, 7, 437
- Hauy's law, 1, 6
- Hay-fever, 2, 306-307  
fragrance, 2, 146-147
- Heart,  
embryonic chick, of, 9, 294  
frog's, 9, 294
- Heat,  
adsorption, of, 6, 255  
charcoal, on, 6, 108-111  
alloying, of, 5, 71-73  
animals, from, 1, 378  
atomic, 1, 535; 8, 103  
caloric theory, 4, 359-360  
capacity, 1, 235, 535 (*see also Specific heat*)  
elements, of, 5, 189-196  
gases, of, 5, 329-358
- Heat—*cont.*  
capacity—*cont.*  
high temperature, of, 4, 144  
cells, from, 1, 186  
chemical,  
combination, 4, 142  
effect, 1, 136  
colour effect on, 2, 424-434  
conduction, 1, 98 (*see also Conduction, thermal*)  
gases, by, 3, 256  
kinetic theory, 3, 132-133  
metals, by, 5, 412-413  
vibration, and, 1, 109  
crystals,  
formation of, 9, 79  
solution of, 9, 79  
Daniel cell, from, 1, 186  
dynamical theory, 5, 324-358; 8, 103  
electric potential, and, 1, 368  
electricity, and, 1, 29-30  
energy, and, 1, 196-201, 235-237; 2, 77, 420; 4, 1-6  
electron evaporation, 7, 495-496  
engine, 1, 198; 2, 420; 6, 349-360  
evaporation, 2, 398-404  
fluid theory, 1, 29  
friction, from, 1, 196; 2, 276-281  
gold leaf, effect on, 1, 216, 294-295  
history of research on, 3, 268-271  
hydration, effect on, 2, 210-211, 424-434  
hydrogen-oxygen reaction, 2, 148  
insulation, 1, 185; 2, 275-281  
in photochemistry, 7, 80  
isomerism, of, 1, 56  
kinetic theory, 5, 359-360  
Leslie's work, 3, 268-269  
loss of magnetisation by, 1, 39  
magnetism, and, 4, 11-12  
effect on, 1, 195  
from, 1, 29-33, 197; 2, 331  
measurement, 8, 253-270  
mechanical equivalent, 1, 183, 196-201, 327-373; 2, 77, 420; 4, 275  
molecular change, and, 1, 4  
motion, and, 1, 196-201; 2, 276-279; 3, 2, 136-137  
nature of, 3, 268-271  
neutralisation, 6, 96, 102

**Heat—cont.**

- origin of, 3, 271–272
- ozone, effect on, 1, 24
- phosphorescence, and, 1, 309–310
- photosynthesis, 9, 194
- quantity, 2, 148
- radium slats, from, 6, 47–48
- radiant (*see Infrared radiation*)
  - and light, identity, 1, 42–48; 2, 330–334; 3, 271–272
- reaction and equilibrium, 2, 149–150
- Rumford's work, 2, 276–281; 3, 268–269
- silver cyanide, from, 1, 56
- sound from, 3, 2
- sun, from, 2, 331
- suppression, 8, 468
- surface tension, and, 3, 348
- Tesla coil, from, 4, 170
- theory, 1, 29, 42–48, 78, 196–201, 346; 2, 275–281
- transmission of liquid air 5, , 465
  - studies by Rumford, 2, 275–281
  - through liquid oxygen, 4, 233
- Tyndall's work, 4, 275–278
- weight of, 2, 276–281
- work, and, 1, 181–183, 196–201, 235; 2, 77
- Young's virus, 5, 279

**Heated,**

- bodies, sound from, 1, 107–110
- cathode, 7, 488

**Heater, graphite spiral 7, 241****Heating and illumination effects, 1, 47**

- combustion, by, 3, 377–393
- diaphragm, 2, 411–414
- domestic, 3, 390–393; 7, 413
- electric, 7, 239
- electromagnetic waves, by, 4, 73
- gravity, from, 4, 168
- negative rays, effect of, 3, 54–57
- planets, of, 1, 307–308
- power of coal and wood, 2, 276
- radiation, by 1, 391–392; 3, 378–379
- rotation in a magnetic field, by, 2, 111–112
- steam, 2, 276
- two-stage, 3, 377

**Heavy,**

- atoms, transmutation, 10, 252–257
- use in X-ray diffraction, 9, 78

**Heavy—cont.**

- glass, 9, 104, 132
  - ferric oxide in, 9, 161
  - X-ray opacity, 4, 487
- hydrogen (*see Deuterium*)
- oxygen, 10, 68–69
- water (*see Deuterium oxide*)
- Hedgehog transformer, 4, 403
- Height,
  - atmospheric pressure, and, 3, 105–106
  - chemical action of sun, and, 1, 324–325
- Helenien, 10, 231
- Helical structure of quartz, 7, 338–340
- Heliotrope, 3, 372
- Heliotropin, 6, 12–13
- Helium, 7, 64–79; 9, 312–319
  - abundance, 9, 313
  - adiabatic expansion, 6, 383
  - adsorption on charcoal, 6, 110, 215, 348, 397–404; 7, 66–67
  - air, in, 7, 67, 455–465
  - airships, in, 9, 316
  - $\alpha$ -particles, and, 6, 242–247; 7, 71, 501; 9, 313–314
  - argon ratio, 7, 462
  - atmosphere in, 4, 455–456; 7, 141
  - atomic,
    - number, 8, 132
    - spectrum, 7, 76; 8, 32–46, 373
    - structure, 8, 42–43, 221–226
    - weight, 5, 467
  - atoms, 8, 522–536
    - constituent of, 8, 129
  - balloons, in, 9, 316
  - band spectrum, 8, 39, 372–373
  - Bath gas, in, 4, 455; 5, 157–161; 7, 67
  - boiling point, 5, 467; 6, 438; 7, 67, 71 237; 10, 71–72
  - Buxton springs, in, 4, 455
  - clevite, 5, 466
  - collision with  $\alpha$ -particles, 8, 245–246, 536; 9, 15–16
  - condensibility, 6, 383
  - cost, 6, 384
  - critical,
    - pressure, 7, 67
    - temperature, 7, 67
  - density, 5, 467; 9, 313

**Helium—cont.****density—cont.**

charcoal, on, 6, 218

liquid, of, 9, 315

diffuse series, 8, 36–37

**diffusion,**

high temperature, at, 7, 459

through rubber, 7, 471–486

discovery, 4, 454–455; 5, 466; 8, 32;

9, 312–313

electric discharge, from, 7, 402–404

electronic structure, 8, 327

evaporation temperatures, 7, 226;

10, 71–72

fountain effect, 10, 465–468

French springs, in, 6, 384

**gas,**

natural, in, 6, 384; 9, 315–317

thermometer, 5, 319

**heat,**

conduction of liquid, 10, 464–467

of adsorption on charcoal, 6, 109–

110, 255, 397–399

hydrogen, from, 9, 264

spectrum, effect on, 8, 241, 372

ion, 6, 242–244; 8, 522–536 (*see also**a-particle*)

mass-charge ratio, 6, 284; 7, 296

isolation, 6, 113–115, 226–228

isotopes, 8, 338–340; 10, 25

latent heat, 6, 383

liquefaction, 5, 472; 6, 24, 384, 437–

438; 9, 314–315

attempted, 5, 314

**liquid,**

conductance, in, 7, 234

entropy of, 10, 464

expansion of, 10, 463–464

levelling of, 10, 489–473

phases, 10, 464

properties, 10, 463–477

theory of, 10, 474–477

thermal conductivity, 464–467

line intensities, 8, 240

low-pressure spectrum, 8, 242

mass-charge ratio, 6, 284; 7, 296

mass spectrum, 8, 338–340

nebular spectrum, 8, 242

nucleus, 8, 520

dimensions, 9, 9–10

stability, 9, 8, 314

**Helium—cont.**

occurrence, 7, 455–465; 9, 315

 $\alpha$ -particle bombardment, 8, 245–246,

536; 9, 15–16

 $\lambda$  point, 10, 463–474

positive rays, 6, 242–244

predicted boiling point, 6, 382–384

principle series, 8, 36–37

production, 9, 316–317

purification, 5, 322

radiometer, 6, 257

radium from, 9, 313–314

rate of emission, 6, 436–437; 7,

72–77

rarefaction with height, 7, 173

ratio of heat capacities, 5, 335; 8, 104

recoil, 8, 246, 536; 9, 415

refractive index, 6, 383

refractivity, 4, 454; 5, 468

second sound, 10, 477

sharp series, 8, 36–37

solidification, 10, 463

**solubility,**

liquid air, in, 5, 468

water, in, 4, 495–456

**spectrum,**

secondary, 8, 36–39

variations, 8, 372–373

Stark effect, 8, 239

stars, in, 8, 32, 39; 9, 312

stream, hydrogen freezing in, 6, 77

sun, in, 8, 32; 9, 312

temperature, at low, 6, 248–261

thermometer, 7, 224–228

thorianite, in, 6, 260

uranium, from, 9, 312–313

valency, 8, 117

vapour pressure, 5, 319

and temperature, 7, 67; 10, 93

viscosity, 4, 454–455

of liquid, 10, 468–469

X-ray diffraction of liquid, 10,

473–474

zero-point energy, 10, 463

Helmholtz, 4, 381–396

army doctor, as, 4, 382

Berlin, in, 4, 383

binocular vision, theory of, 4, 394

biologist, 4, 381

Bonn, in, 4, 383

**Helmholtz—cont.**

- book,
  - physiological optics, on, 4, 384
  - sensation of sound, on, 4, 384
- colour vision, theory of, 4, 394
- death, 4, 381
- educational opinions, 4, 394–396
- Heidelberg, in, 4, 383
- invention,
  - ophthalmoscope, of, 4, 394
  - stereoscope, of, 4, 394
- Konigsberg, in, 4, 383
- life, 4, 381–389
- mathematician, 4, 381
- medical education, 4, 382
- mother, 4, 382
- physicist, 4, 381
- professor of anatomy, 4, 383
- resonator, 5, 57
- work on,
  - conservation of energy, 4, 383
  - electromagnetism, 4, 394
  - electrolysis, 4, 394
  - galvanic cell, 4, 394
  - optics, 4, 393–396
  - sound, 4, 384–396
  - vortices, 4, 394
- Hemihedrim, 1, 5–7, 303–304, 333
  - of zinc blende, 7, 338
- Hemispheres, Magdeberg, 9, 233
- Hemispherical liquid surface, 3, 346
- Hemitrope, 4, 187
- Hemlock, 6, 33
- Hemp fibres, 9, 246
- Henry's law, 7, 473
- Heusler alloy, 8, 489–509
- Heptane,
  - formula, 1, 545; 3, 480–481, 486
  - infrared transmission, 8, 285
  - viscosity, 5, 141–154
- Heptaparallelohedron, 7, 335
- Heptene, 2, 145
  - from coal, 1, 399
- Heptyl alcohol, 2, 389–390
  - formula, 1, 546
  - silicon-substituted, 2, 398–390
- Heptylamine, 2, 145
- Heptylene, 1, 399
- Herring, photobacteria in, 7, 84
- Hertz, 4, 286–287, 321–349
  - character, 4, 322

**Hertz—cont.**

- life, 4, 321
- oscillators, 3, 487; 4, 325
  - large, 4, 330
- papers, 4, 349
- Hertzian waves, 4, 18–25, 321–349
  - focusing, 4, 347
  - glass plate, effect of, 4, 346
  - properties, 4, 502; 5, 11–26
  - receiver, 5, 14–17
  - reflection, 4, 346
  - refraction, 4, 347
  - screening, 4, 99
  - short, 5, 14–26
  - wavelength, 9, 224
- Heterogeneous catalysis, 8, 30
- Hexachlorobenzene,
  - discovery, 9, 96
  - infrared transmission, 8, 286
- Hexachloroethane, 9, 96
- Hexadecane, 10, 417
- Hexadecyl alcohol, 1, 546
- Hexaethyl disilicon, 2, 391
- Hexagonal,
  - close-packed, 7, 126
  - crystal angles, 7, 351
  - elements, 7, 128
  - prism, 7, 335
  - symmetry, 7, 330–333
- Hexahydroxybenzene, 4, 207
- Hexakis-tetragonal symmetry, 7, 343
- Hexamethyl benzene, 9, 215–216
- Hexamethylene diamine, 2, 248
- Hexane, 2, 389
  - coal, from, 1, 399
  - formula, 1, 545, 2, 486
  - hydrogenation, 9, 351–352
  - infrared transmission, 8, 285
  - refraction, 6, 157–159
  - silicon-substituted, 2, 389
  - spectrum, 7, 362
  - viscosity, 5, 141–154
- Hexene, 1, 399
- Hexoses, 9, 50–51
- Hexyl,
  - alcohol, 1, 479
  - formula, 1, 546
  - iodide, 8, 285
- Hexylene, 1, 399
  - refraction, 6, 159
- Hielmite, 3, 410

**High,**

explosives, 9, 103  
frequency A.C., 4, 167-182; 5, 501;  
7, 266-293

alternators, 7, 267-278

discharges, 4, 168-182

in gases, 4, 174-176

induction coil, 4, 169

insulation, 4, 172

oscillators, 10, 172

potential transformers, 4, 401

power microscopy, 6, 120-134

pressure, 2, 294-301; 7, 16-35; 8,  
291-308

apparatus, 7, 29-32

bomb, 6, 312; 8, 463-465

bubbles, 8, 176-178

bullets, from, 8, 303-308

cell, 3, 510

combustion, 8, 462-488

granite, effect on, 8, 291-292

ice, effect on, 8, 294

limestone, effect on, 8, 291-292

measurement, 8, 463-465

spectra, 8, 242

resolution spectroscopy, 7, 377

speed,

camera, 9, 474-475; 10, 11

film, 10, 11

photography, 10, 11-14

steel, 7, 34

temperature, 7, 16-35, 235-246; 8,  
291-308

chemistry, 3, 80-90

diffusion, 7, 465-469

granite, effect on, 8, 291-292

limestone, effect on, 8, 291-292

measurement, 3, 87-90; 5, 36-52;  
7, 238

protoplasm, 7, 61

thermometry, 7, 238

vacuum, 3, 38-59, 406; 4, 221-227;  
5, 285, 320; 6, 248-261

viscosity, 6, 67-73

voltage,

A.C., 4, 167-182

discharges, 3, 91-120

transformer, 4, 401

transmission, 6, 375

Hipentine, 6, 12

Hippuric acid, 4, 377

**History of,**

benzene, 3, 362-364

coal-tar, 3, 360-376

photography, 4, 39-42

research on heat, 3, 268-271

Hofmann violet, 2, 188; 3, 34

Hollyhock, 9, 115

Holohedral symmetry, 7, 330

Holtz machine, 3, 468-469; 4, 171

Holweck pump, 9, 241

Homogeneous solids, 3, 60-62

Homologues of hydrogen, 1, 90-93

Homologous series, 1, 478, 544-548,  
560-562; 2, 193, 478-492

viscosity, 5, 135

Honey, 6, 67

Honeystone, 6, 231

Hoops, 3, 136

Hoopes, 4, 237

Horizontal soap films, 8, 436-443

Hormone, thyroid (*see Thyroxin*)

Horn, 10, 429

acoustics, 8, 369

conical, 5, 476

elliptical, 5, 479 •

phosphorescence, 4, 377; 5, 464

X-ray diffraction, 9, 457

**Horse,**

breeding, 2, 276

carotenoids, 10, 235

chestnut bark, 1, 310

quercetin in, 9, 116

methaemoglobin, 10, 432

**Human,**

body, reflection of Hertz waves, 4,  
346

eye, 3, 264

scalp, 4, 186

skin, 4, 186

Humite, 7, 130-133

**Huygen's,**

gear, 4, 152

zones, 3, 461; 5, 478

Hydrargillite, 10, 281

Hydrastis canadensis, 7, 364

Hydrate of baryta and lime, 1, 128

**Hydrated,**

copper sulphate, 7, 299

phosphoric acid, 2, 207

salts and colour, 2, 424-434; 9, 159

volume, 6, 2

**Hydrated—cont.**

silica, 10, 288–290

**Hydrates, vapour pressure, 2, 526–527****Hydration,**

Graham's work, 2, 209–211

heats of, 2, 210–211

in solution, 2, 424–434

**Hydraulic,**

jack, 7, 29

model of muscle response, 5, 420

**Hydrazine, 7, 195–196**

discovery, 7, 196

production, 7, 196

reaction with nitrous acid, 7, 197

**Hydrazoic acid, 7, 195–197**

discovery, 7, 197

physiological action, 7, 197

production, 7, 197

properties, 7, 197

reaction with,

hydrocyanic acid, 7, 203

hypochlorous acid, 7, 199

silver nitrate, 7, 197

test for, 7, 197

**Hydrazonium azide, 7, 196–197****Hydride,**

copper, 1, 93

ion, 7, 186–187

**Hydrides dissociation, 3, 190**

metal, 3, 190

**Hydriodic acid, 1, 327–328 (see also***Hydrogen iodide)***Hydrobenzamide, 1, 452****Hydrobromic acid, 1, 327–328 (see also***Hydrogen bromide)***Hydrocarbons, 1, 154–157; 2, 476–479**

aliphatic, 1, 544–545

viscosity, 5, 141–154

aromatic, viscosity, 5, 142–154

Bath gas, in, 5, 159

charcoal, adsorption on, 6, 118–119

colour, 6, 415

condensation from coal-gas, 5, 320–322

cracking, 9, 350–352

crystal structure, 7, 336

electric discharges in, 1, 473

explosions, 6, 299–313

flames, 6, 299–313

light emission, 5, 32–34

spectra, 3, 174–186

**Hydrocarbons—cont.**

hydrogenation, 9, 350–352

infrared transmission, 8, 285

liquid fluorine, action of, 5, 466

molecular refraction, 6, 156–166

structure, 9, 508

volumes, 7, 336

oxidation chemiluminescence, 9, 219

phosphorescence, 4, 377

sources, 3, 361

synthetic production, 9, 352–356

thermal decomposition, 9, 349–352

X-ray diffraction, 9, 40–47

**Hydrochloric acid, 1, 75, 327–328, 331–332; 2, 265 (see also***Hydrogen chloride)*

chlorine photolysis, effect on, 1, 203

concentrated, 6, 95

conductivity, 6, 95–96

diffusion through rubber, 7, 485

formula, 1, 154–155; 2, 265–266

fumes, 2, 166–172

industrial oxidation, 3, 500–501

maximum conductivity, 5, 491

-nitric acid mixtures, 2, 268

phosphorescence, 1, 320–326

**Hydrocyanic acid, 1, 452, 158–159; 5, 86; 7, 195 (see also Hydro-***gen cyanide)*

hydrolysis, 1, 477

nitrogen, from active, 7, 310

reaction with hydrazoic acid, 7, 203

reduction, 1, 480

synthesis, 1, 273

**Hydrodynamics, 2, 510–517; 3, 290–299; 4, 248–257; 5, 215–****232; 7, 431–444**

frictionless, 7, 431–432

**Hydroelectric power, 6, 182****Hydrofluoric acid, 1, 327–328 (see also***Hydrogen fluoride)*

constitution, 5, 85–86

discovery, 5, 85

electrolysis, 5, 87–95

glass,

action on, 4, 246–247

etching of, 1, 259; 5, 397–403

flattening, 4, 244

polishing, 5, 397–398

preparation, 5, 85

silicates, action on, 5, 85



**Hydrofluoric Acid—cont.**

tantalum, action on, 7, 49

toxicity, 5, 88

**Hydrofluosilicic acid, 2, 384****Hydrogen, 7, 455–486 (see also***Deuterium)*

acetylene combustion, 6, 308

adiabatic expansion, 4, 467; 6, 383

adsorption,

charcoal, on, 6, 105, 384, 395–404;  
7, 66–67

heat of, 6, 109–110, 255–256

isotherm, 6, 254

air, in, 5, 470; 7, 455–465

explosion, 8, 469–470

alcohol, diffusion through rubber,

7, 485–486

atomic, 9, 221; 10, 390–398

heat, 6, 88; 7, 407

mass, 7, 179

number, 8, 132

radius, 9, 501

refraction, 2, 138, 541; 6, 162

spectrum, 1, 433, 512; 5, 469; 8,  
32–46, 371–372Balmer series, 8, 33–46, 239,  
371–372

helium, effect of, 8, 372

impurities, effect of, 8, 371–372

line intensities, 8, 240–241

line shapes, 8, 240–241

Lyman series, 8, 34–46

Paschen series, 8, 34–46

primary, 8, 32

secondary, 8, 32–33, 242, 371–  
372

Stark effect, 8, 239

variations, 8, 372–373

Zeeman effect, 8, 33

structure, 8, 42, 59, 221

volume, 5, 213, 323; 7, 336, 401

weight, 1, 500–508; 8, 340; 10, 17,  
47

Bath gas, in, 7, 67

bending of mirrors, 4, 370–371

bicarburet of, 9, 98–100

boiling, 5, 284

point, 4, 467; 5, 208–210, 285; 6,  
77; 7, 67, 227

calculated, 4, 160

Bohr radii, 8, 59

**Hydrogen—cont.**bromide, 1, 327–328 (*see also*  
*Hydrobromic acid*)

formula, 1, 455

infrared absorption, 1, 390

solidification, 9, 98

ultraviolet absorption, 1, 430–431

zero-point energy, 10, 57–60

carbon arc in, 3, 176–177

carbon disulphide, reaction with, 2,  
354–355

carbon electrodes, in, 3, 178

carbon monoxide,

flame,

photography, 9, 477–478

velocity, 4, 145

synthesis, 9, 352–356

carbon disulphide flame, 3, 260–261

catalytic reaction with oxygen, 1,  
159; 7, 406–408chloride, 1, 327–328, 331 (*see also*  
*Hydrochloric acid*)

ammonia reaction, 7, 100

charcoal, adsorption by, 6, 105,  
108, 395

critical constants, 3, 315

depression of freezing-point, 2,  
523

diamagnetism, 4, 220

electrical discharge, 3, 181

formula, 1, 445–455, 536, 539–  
541

heat of formation, 2, 149

industrial oxidation, 2, 269–270

infrared,

absorption, 1, 390; 8, 284

spectrum, 3, 213; 9, 226–227

internuclear distance, 9, 501–502

light scattering, 9, 274

liquefaction, 9, 98

by Faraday, 2, 56

mass spectrum, 8, 136–137

molecular structure, 1, 402, 545–  
547; 9, 501–502photochemical production, 1, 320–  
326

preparation, 5, 85

spectrum of arc in, 3, 181

thermal decomposition, 2, 149

ultraviolet absorption, 1, 430–431

zero-point energy, 10, 57–60

Hydrogen—*cont.*

- chlorine actinometer, 1, 457–458
  - effect of rays, 4, 502
  - explosion, 1, 415
  - reaction, 7, 100
- chromic oxide, reaction with, 1, 161
- Clausius-Clapeyron equation, 6, 81
- coal, from, 1, 399
- coal-gas, separation from, 5, 157
- collision with  $\alpha$ -particle, 8, 245–246
- combustion in liquid oxygen, 4, 463
- constituent of atoms, 8, 127
- cooling of, 4, 467
- cosmic, 8, 40
- critical constants, 5, 202–204
  - density, 5, 322
  - point, 4, 466
  - pressure, 5, 208; 7, 67
  - temperature, 5, 208; 7, 67
- cyanide, 1, 52; 5, 86 (*see also Hydrocyanic acid*)
  - coal, from, 1, 400
  - electrical discharge, 2, 198
  - formation in electric arcs, 3, 80–86
  - formula, 2, 197
  - hydrolysis, 1, 477
  - liquefaction, 3, 22
  - molecular structure, 9, 504
  - preparation, 2, 145
  - reduction, 1, 480
  - synthesis, use in, 2, 145
- demonstration of liquid, 5, 313
- density, 2, 154
  - charcoal, in, 6, 218
  - liquid, of, 4, 467; 5, 207, 212, 284, 322; 6, 8–9, 77
    - and temperature, 5, 323
  - metals, in, 2, 237–239
  - organic compounds, in, 5, 322
  - palladium alloy, in, 5, 322
  - solid, of, 5, 319; 6, 428
- deuterium exchange, 10, 61
- dielectric breakdown, 3, 102–104
- diffusion, 2, 398
  - at high temperature, 7, 465–469
  - into carbon dioxide, 2, 221–222
  - through,
    - black films, 8, 173–176
    - bubbles, 8, 78–87, 176–178
    - graphite, 2, 41–44, 224–229
    - iron, 2, 45, 233–239

Hydrogen—*cont.*

- diffusion—*cont.*
  - through—*cont.*
    - platinum, 2, 39–44, 233–239
    - rubber, 2, 38–44, 229–233; 6, 7; 7, 471–486
- discovery, 2, 315–316; 5, 282
- dissociation, 9, 221
- Dulong and Petit's law, 6, 88
- effusion rate, 2, 40–44, 224–229
- electric discharge, 2, 154
  - in moist, 3, 199–200
- electron absorption, 5, 47
- electropositive character, 1, 138
- escape velocity, 5, 420
- ethane explosion, from, 6, 313
- ether evaporation, effect on, 2, 398
- ethylene combustion, 6, 408
- evaporation temperature, 7, 226
- exchange reactions, 10, 19, 60–66
- expansion, 4, 467
  - coefficient of liquid, 5, 284, 323
- flame, 1, 89
  - heating effects, 2, 148–150
  - light emission, 1, 494; 5, 27; 8, 468–469
  - pressure, under, 2, 153
  - sound from, 3, 4
  - spectrum, 3, 199–200
  - temperature, 1, 432; 7, 237
  - velocity, 4, 142, 145–147; 6, 300; 7, 409; 8, 469; 9, 468
- fluoride, 1, 327–328 (*see also Hydrofluoric acid*)
  - conductance of pure, 5, 89–90
  - constitution, 5, 85–86
  - deuterium exchange, 10, 59–60
  - formula, 1, 446, 455
  - preparation, 5, 85
  - properties, 5, 85
  - toxicity, 5, 88
  - zero-point energy, 10, 57–60
- fluorine, action of liquid, 5, 466
- formation, 1, 90–93
  - from phosphorous acid, 1, 93
- fractional distillation, 10, 18
- freezing in helium stream, 6, 76–77
- glow discharge strata, 3, 115–120
- heat of,
  - adsorption on charcoal, 6, 109–110, 255–256

**Hydrogen—cont.****heat of—cont.**

combustion, 8, 468

dissociation, 9, 221

heavy (*see Deuterium*)

helium,

conversion to, 9, 264

purification by liquid, 5, 322

high-pressure combustion, 8, 468–488

homologues, 1, 90–93

ignition temperature, 8, 468

infrared,

absorption, 1, 309, 346

spectrum, 8, 34–46

intermolecular distance, 9, 507–508

iodide, 1, 327–328 (*see also Hydriodic acid*)

deuterium exchange, 10, 59–62

formula, 1, 455

solidification, 9, 98

ultraviolet absorption, 1, 430–431

zero-point energy, 10, 57–60

ion, 6, 182

acids, in, 8, 118–119

charge on, 5, 407; 8, 115

concentration, (*see pH*)

mass-charge ratio, 7, 186–188

radius, 9, 502

iron oxide, reduction of, 2, 150

isolation, 6, 113–115, 226–228

isotopes, 8, 338–340; 10, 15–27, 50

separation of, 10, 18–21, 49

isotope-effects, 10, 19, 60–70

jet apparatus, 4, 476

Joule–Thomson effect, 4, 5

latent heat of evaporation, 5, 208, 284; 6, 77, 87–88, 431

light-scattering, 9, 275

limiting density, 5, 322–323

liquid, 5, 198–199, 282–292

apparatus for, 5, 463

applications of, 5, 365–368

bacteria, effect on, 5, 470–471

calorimetry, 6, 74–89, 7, 392–401

dispersion of, 5, 207

drops of, 7, 230–232

properties, of, 5, 458–459

specific heat of, 5, 213, 284

surface tension of, 5, 466

reaction with solid fluorine, 6, 424

**Hydrogen—cont.**

magnesium compound, 3, 188–189

magnesium ore in, 3, 186–187

magnesium spectrum, 3, 70–71, 206

magnetism, 1, 68

mass-charge,

ratio of ion, 5, 49

spectrum, 7, 188; 8, 338–340

maximum density of gas, 5, 322–323

melting point, 5, 319, 466; 6, 434; 7, 141

mercury sensitisation, 9, 220

metallic character, 5, 319

meteorites, in, 2, 48, 233–239

molecular,

spectrum, 8, 33

structure, 1, 402

volume, 6, 8–9

molecule-ion, 7, 156–158

Newton, prophesied by, 7, 147

nitrogen jelly, 4, 468

reaction, 8, 294

nitrous oxide flame velocity, 4, 145–146

reaction, 7, 102

number of electrons, 8, 58

occlusion by,

copper, 2, 47

gold, 2, 47

iron, 2, 47, 233–239

palladium, 2, 47, 233–239; 3, 190; 5, 212–213

platinum, 2, 45–46, 233–239

pressure, 6, 254

silver, 2, 48

tantalum, 7, 50–51

occurrence, 7, 455–465

oxygen,

atoms, action of, 5, 474

blowpipe, 9, 96

explosion, 2, 422–423

infrared, by, 1, 537

rate, 3, 440–443

temperature, 3, 449–450

reaction, 5, 561–562; 7, 100–102

catalysis, 9, 399

charcoal, by, 6, 395

platinum, by, 2, 72; 8, 28

p,V,T data, 5, 202–203, 363

palladium, reduction catalysed by, 2, 46, 233–239

**Hydrogen—cont.**

- $\alpha$ -particle bombardment, 9, 15–16
- Paschen series, 8, 34–46
- peroxide, 1, 155; 6, 165
  - bleaching by, 1, 155
  - catalysed decomposition, 8, 27
  - formation, 5, 261
  - instability, 3, 550–551
  - kinetics of iodine oxidation, 2, 134–135
- peroxides, from, 1, 282–283
  - phosphorous glow, 4, 15
- photographic plate, action on, 5, 260–263
- photochemical reaction with chlorine, 1, 320–326
- photography at temperature of liquid, 6, 424
- positive rays, 6, 241–242
- preferential combustion, 6, 301–313
- preparation pure, 2, 498
- pressure at melting point, 7, 141
- primary spectrum, 8, 32
- production of solid by charcoal, 6, 389–390
- protoplasm, in, 7, 61
- quenching of sodium fluorescence, 10, 388–389
- radiometer, 6, 257–258
- radium C reaction, 8, 456
- rarefaction with height, 7, 173
- ratio of heat capacities, 5, 337
- recoil, 8, 246–252, 536; 9, 415
- refractive index, 4, 454
  - of liquid, 5, 207
- refractivity, 5, 468
- saturation current, 6, 18
- secondary spectrum, 8, 32–33, 242, 371–372
- selenide, 1, 328
  - formula, 1, 455
- silver fluoride, reduction of, 5, 87
- solid, 5, 313–323, 466–467; 6, 381; 7, 138–141
  - air in, 4, 460–461
- solidification, 5, 316–317
- solubility in liquid air, 5, 468
- spheroidal state, 6, 382
- Stark effect, 8, 239
- stars, in, 2, 48, 233–239
- stream, nitrogen freezing in, 6, 76

**Hydrogen—cont.**

- sulphide, 1, 328, 331–332
- acid properties, 5, 86–87
- carbon arc, from, 3, 81
- charcoal, absorption by, 6, 105, 395
- coal, from, 1, 399
- coal-gas, in, 2, 353
- coal-gas, removal from, 2, 304–305
- critical constants, 3, 315
- formula, 1, 450, 455
- infrared absorption, 1, 349
- liquefaction, 9, 98
- molecular structure, 1, 482
- oxygen explosion, 3, 447
- poisoning of platinum, 9, 399
- solid, 3, 25
- solidification, 9, 98
- sulphur dioxide reaction, 7, 102
- test, 2, 355
- ultraviolet,
  - absorption, 1, 430–431
  - spectrum, 3, 263
  - viscosity, 2, 219–221
- sun, in, 1, 433
- superior limit of density, 5, 322
- telluride, 1, 328, 455
- thermometer, 5, 450; 7, 224–228
- torsion balance, use in, 4, 370
- translational velocity, 5, 363
- ultraviolet absorption, 1, 430–431
- valency, 1, 459–464; 5, 560
- vapour pressure, 5, 319; 6, 88
  - and temperature, 5, 208–209; 7, 67
- viscosity, 2, 219–221
  - and temperature, 5, 248; 6, 387–388
- water diffusion through rubber, 7, 485–486
- Zeeman effect, 8, 33
- Hydrogenated palladium, 2, 237; 5, 364
- Hydrogenation, 10, 63–66
  - catalysts, 10, 63–64
  - coal, of, 9, 329–348
  - ethane, of, 9, 350–351
  - hexane, of, 9, 351–352
  - hydrocarbons, of, 9, 350–352
  - mechanism, 10, 65

**Hydrogenation—*cont.***

tar, of, 9, 344–356

**Hydrogenum** (*see Hydrogen and Pal-*  
*ladium*)**Hydrolysis of,**

amyl acetate, 10, 68–69

carbohydrates, 9, 50–51

esters, 1, 575

ethyl acetate, 8, 29

hydrocyanic acid, 1, 159

proteins, 8, 26

vitamins, 8, 375

**Hydroxyquinol, 10, 117–118****Hydroquinone, 1, 259**

colour, 6, 415

phosphorescence, 4, 377

quinone, and, 9, 20–21

**Hypophasic pigments, 10, 231****Hydrophilic,**

character, 10, 418

clay, 10, 155

colloid, 10, 155

**Hydrophobic character, 10, 417****Hydrosulphocyanic acid, 1, 21****Hydroxyl group, auxochromic charac-**  
**ter, 5, 529****Hydroxyl ion, 6, 102**

radius, 9, 86

**Hydroxylamine, 7, 195; 5, 548–549****Hydroxylated flavones, 9, 116****Hydroxylation in flames, 6, 301****Hydroxyphenyltetrazole, 7, 203****Hydroxysilane, 2, 387****Hydroxytetrazole, 7, 203****Hypersensitive dyes, 10, 133****Hypersthene, 5, 22****Hypochlorous acid, 1, 138, 155, 328**

formula, 1, 454, 539–541

hydrazoic acid, reaction with, 7,  
199

molecular structure, 1, 557

**Hyponitrous acid, 1, 271****Hypophosphites, 4, 48****Hypophosphorous acid, 1, 330****Hyposulphites, 2, 134****Hysteresis, 4, 136, 423–425, 511–516; 8,**  
**508–509**

coefficients, 8, 508

definition, 4, 511

demonstration, 4, 511

loading, 4, 639

**Hysteresis—*cont.***

loss, 4, 136, 512–515; 8, 509

demonstration, 4, 514–515

low temperature, of, 5, 461

magnetic induction, and, 8, 508–509

repulsion, 8, 509

temperature, and, 5, 461

vibration, effect of, 4, 136–137

**Hyvac pump, 9, 237****I*****i* factor, van't Hoff, 5, 495****Ice, 2, 518–527; 10, 356–383**

age, 9, 228

allotropy, 6, 4, 427; 7, 23; 8, 294;  
10, 380–383

calorimeter, 5, 189–191; 6, 74

conduction, 9, 396

contraction on melting, 7, 17

crystal structure, 8, 380; 10, 359,  
370–371

crystals, 10, 377–380

density at,

–185°, 6, 427

–200°, 6, 3

dielectric,

properties, 5, 462

relaxation, 9, 430

expansion, 6, 3, 427

evaporation,

at –78°, 7, 227

temperature, 7, 225–226

flowers, 10, 380

Tyndall's, work, 4, 274

glaciers, in, 1, 253

heat,

action of radiant, 1, 252–253

latent, of fusion, 1, 253–254; 6, 3

specific, 7, 233–234

and temperature, 6, 83–85, 431

high pressure, at, 8, 294

low temperature, at, 6, 426–428

melting point and pressure, 7, 17;  
10, 360–373

molecular volume, 6, 8–9

phase changes, 6, 4

phase diagram, 10, 380–383

phases, 6, 427; 7, 23; 8, 294

physical properties, 1, 252–255

**Ice—*cont.***

- plasticity, 10, 359–373
- pressure effects, 6, 427; 7, 23
- regelation, 1, 254–255; 4, 158; 10, 360–373
- Tyndall's work, 4, 274
- structure, 6, 426–428
- ultraviolet absorption, 1, 430–431
- vapour pressure and freezing point, 7, 8–9
- volatility, 2, 400
- wire, 6, 4

**Iceland spar (*see also Calcite and Calcium carbonate*)**

- allotropy, 1, 36
  - birefringence, 2, 138–139, 169, 274, 332, 333
  - cleavage planes, 9, 149–150
  - crystals,
    - form, 1, 303
    - structure, 8, 323–325, 328–329; 9, 83, 87
  - expansion coefficient, 4, 462
  - free calcium in, 9, 166
  - gravitational effects, 5, 305–306
  - infrared birefringence, 2, 332–333
  - lens, 8, 316
  - magne-crystals, 2, 88–96
  - magnetic field, in, 9, 136–137
  - magnetic properties, 1, 80, 193–195
  - microwave birefringence, 5, 22
  - optical properties, 1, 5; 2, 395–397
  - polariscope, in, 4, 137
  - polarisation of light, 2, 169
  - polariser, 3, 519
  - prism, 8, 316
  - refractive index, 9, 462–463
  - scarcity, 3, 523; 7, 371–372
  - sodium nitrate crystallisation, 7, 326–328
  - strata in, 3, 494
  - ultraviolet absorption, 1, 430–431
  - X-ray,
    - diffraction, 7, 453
    - opacity, 4, 487
- Ideal solutions, 7, 13**
- Identity of light and heat, 3, 271–272**
- Idocrase, 5, 22**
- Ignition, 6, 300**
- point, 6, 299**
- Illuminating and heating effects, 1, 47**

**Illuminating and heating effects—*cont.***

- gas, 9, 98
- microscope, 6, 123
- phase, 6, 126–128
- power of coal-gas, 2, 355
- Images, electrical, 4, 94
- Imaginary time, 8, 184
- Immunisation, 6, 437
- Impacts, molecular, 4, 175 (*see also Collisions*)
- Imperfect gases, 4, 5; 5, 363; 8, 347
- Imperial purple, 10, 339
- Impurity,
  - effect on hydrogen spectrum, 8, 371–372
- foam, and, 4, 26
  - melting point, 7, 17
- Graham's work, 2, 208–209
- Incandescent lamp, 7, 46
  - mantle, 6, 388–389
  - surface combustion, 7, 410
- Inclination, magnetic, 1, 10, 73; 4, 7
- Incomplete tetanus, 5, 419
- Indanthrene, 5, 537
- discovery, 9, 25
  - green, 9, 25
- Independent migration of ions, 5, 493
- Index of refraction, 2, 136–139, 540–545
  - Brewster's angle, and, 2, 170
  - lead glass, of, 2, 56–57
  - light velocity, and, 3, 239
  - temperature, and, 1, 299
  - theory, 3, 240–247
  - thermal expansion, and, 1, 299
- India-rubber (*see also Rubber*)
  - bulk modulus, 8, 348
  - diffusion through, 2, 38–44, 229–233; 7, 470–486
  - infrared transmission, 1, 284
  - phosphorescence, 4, 377
  - Poisson's ratio, 8, 351
  - refractive index, 8, 275
  - rope, 2, 22–23
- Indian,
  - bat hair, 4, 186
  - puddings, 2, 276
- Indican, 3, 162
- Indicator, 1, 221; 9, 321
  - ethyl violet, 1, 572
- oil, 10, 422–427

**Indicator—*cont.***

- vapour current, 7, 12
- Indices, crystallographic, 1, 294–304**
  - law of rational, 7, 333
  - Miller, 1, 294–304
- Indigo, 3, 159–173; 7, 195; 9, 101**
- Indigluclin, 3, 162**
  - aniline from, 1, 569
  - breeding of natural, 9, 102
  - colour, 2, 182
  - dyeing, 3, 161; 9, 21
  - films, 3, 535
  - fixing, 3, 168–173
  - formula, 7, 161
  - history, 3, 159–160
  - manufacture, 3, 166–167; 5, 533–536
    - in Bengal, 3, 160–161
  - occurrence, 3, 159–162
  - oxidation by chlorine water, 2, 266
  - printing with, 3, 169
  - reduction, 2, 185
  - structure, 3, 163
  - sulphate, 1, 220
  - synthesis, 3, 159–173; 9, 24–25
  - synthetic, 3, 369
  - U.K. consumption 1879, 3, 159
  - white, 3, 168; 5, 537
  - world production, 3, 159–173
- Indigofera tinctoria, 3, 159**
- Indigotin, 3, 161–162**
- Indirubin, 3, 168**
- Indium, 2, 314–329**
  - atomic,
    - heat, 7, 401
    - refraction, 2, 541
    - spectrum, 1, 509–515; 2, 321–322; 3, 75, 202
    - volume, 7, 401
    - weight, 2, 322–325, 541
  - chemical properties, 1, 510; 2, 322
  - chloride, 2, 322–323
  - discovery, 1, 509–515; 2, 316–322
  - neutron bombardment, 10, 256
  - occurrence, 1, 510; 2, 321
  - oxide, 2, 322
  - physical properties, 2, 322
  - specific heat, 2, 324–325
  - sulphide, 2, 322–323
  - superconductivity, 9, 424
  - tree, 2, 338

- Indol, 3, 166**
- Indoor photography, 10, 134**
- Indophenol, 3, 367**
- Induced radioactivity, 5, 523; 6, 49–52**
- Inductance, 1, 96–106; 5, 558**
  - capitance circuit, 3, 483; 8, 201–202
  - coil, 3, 489
  - demonstration, 4, 77–79
  - effect of oscillation frequency, 3, 483
  - mutual, 4, 431
    - calculation of, 4, 445
- Induction,**
  - apparatus, 1, 177–179
  - heating, 4, 168
  - coil, 1, 177–179, 315–316; 2, 546–549; 3, 94–95, 216
    - Apps, 4, 489
    - high-frequency, 4, 169
    - physiological effect, 4, 169
  - definition of magnetic, 4, 8, 127
  - demonstration, 4, 152–153
  - electrical, 1, 96–106, 174, 181, 265–267; 2, 58–67
  - electromagnetic, 4, 72–74
    - theory of, 5, 564
  - Faraday's work, 4, 151–152
  - furnace, 7, 239
  - hydrogen-chlorine reaction, in the, 1, 204
  - machines, 3, 466–471
  - magnetic, 4, 127–141
  - magneto-electric, 3, 301–304
  - mutual, 3, 301–304
    - demonstration, 3, 95
  - terrestrial, magneto-electric, 2, 58–67
  - Volta-electric, 3, 300–311
- Inductive capacity, 1, 264, 368–369 (*see also Capacitance*)**
- Inductoscript, 4, 495**
- Induline, 3, 368**
- Indulines, 5, 533**
- Industrial,**
  - applications of tantulum, 7, 46–53
  - power, British 1851, 1, 34–41
  - production of aluminium, 3, 496–505
  - vacuum vessels, 6, 218
- Industry and science in 1851, 1, 34–41**
- Industry, coal-tar, 3, 360–376**
- Inert gases, 5, 467–468; 7, 455–486**
  - atmosphere in, 7, 141
  - atomic structure, 8, 226, 327

**Inert gases—*cont.***

- atomic weights, 5, 467
- Bath gas, in, 5, 468; 7, 67
- boiling points, 5, 467
- densities, 5, 467
- electrical discharge,
  - through, 9, 122-130
  - from, 7, 402-404
- electronic structure, 8, 327
- monatomicity, 5, 468
- production, 6, 393
- ratio of specific heats, 5, 468
- ratios, 7, 462
- Inertia, 1, 233-240; 8, 212-221**
  - aether, and, 6, 294
  - electrical, 8, 216-221
  - gravity, and, 1, 233-240
  - magnetic, 3, 287-288
  - moment of, 9, 226-227
  - negative rays, of, 3, 57-58
- Infinite dilution, 5, 492-493
- Inflammation, 7, 409**
  - definition, 6, 300
  - temperature, 4, 142
- Inflammability, spontaneous, 2, 208-209**
- Infrared, 1, 42-48, 427; 2, 330-334**
  - absorption, 8, 283-290
    - and concentration, 1, 349
  - aggregation, effect of state of, 1, 466
  - air, emission of, 1, 381
  - atmosphere, of, 1, 307, 422-426, 531
  - atmospheric moisture, of, 1, 494
  - birefringence, 2, 332-333
  - bromine, of, 1, 390
  - carbon disulphide, of, 1, 390
  - cell, 1, 306, 348
  - chlorine, of, 1, 390
  - crystals, of, 1, 297
  - detection, 1, 305-308; 3, 207-211; 9, 223
    - by phosphorescence-quenching, 9, 223
  - discovery, 1, 305, 529; 3, 268; 9, 223
  - ethyl borate, of, 1, 391
  - ethylene, of, 1, 381-382
  - flames, emission of, 9, 228
  - gases, of, 1, 305-308, 348-351, 390-392, 463-466
  - gratings, 9, 225

**Infrared—*cont.***

- hydrogen, of,
  - bromide, 1, 390
  - chloride, 1, 390
- intensities, 8, 237
- lampblack, 1, 390
- light, properties, 4, 502
- liquefied gases, 4, 259
- liquids, 1, 466, 492-493
- magnetisation, 2, 331-334
- oxygen, 1, 382
  - emission of, 1, 381
  - liquid, 4, 223
- ozone, 1, 392
- photography, 3, 208-211; 7, 205-222; 9, 223
- polluted air, 1, 424-425
- radiation, 1, 42-48, 427, 2, 330-334
  - boiling by, 2, 4
  - combustion by, 1, 529-534
  - polarisation by crystals, 1, 297; 2, 331
  - sound from, 3, 150
- reflection, 2, 332; 9, 223
- refraction, 2, 331-332
- refractive index of sodium chloride, 1, 45
- retina, effect on, 1, 530
- rock salt, 1, 427
- scattering, 7, 213
- sensitisers, 10, 135-147
- solar spectrum, 1, 530; 3, 210-211
- solids, 2, 5
- source, 1, 348; 9, 225
- spectra, 1, 530; 3, 212-215; 9, 223-229
- spectrometer, 1, 306-308, 348; 3, 207-215; 9, 225
- spectrum of,
  - electric lamp, 1, 530
  - liquid water, 1, 531
  - sun, 1, 530; 3, 210-211
- sulphide, 1, 390
- sun, emission of, 1, 319; 2, 331
- theory, 1, 350-351, 463-466, 492-499
- Tyndall's work, 4, 275-278
- vitreous humour, 1, 305, 530
- wave, 7, 487
- wavelength, 1, 287; 9, 224
- Initiation of polymerisation, 10, 262-263**



- Injury, current of**, 5, 422-424
- Ink**,  
invisible, 2, 424-425  
Prussian blue, 1, 104
- Inorganic**,  
chemistry 1, 205  
definition, 1, 144  
colours, 9, 18  
crystals, structure, 9, 77-87  
ion reaction, 8, 26
- Insect**,  
colour, 9, 261-262  
wing muscle, 5, 418
- Instruments**,  
brass, 8, 205-207  
cutting, 9, 97  
musical, 8, 205-211  
tantalum, 7, 50
- Insulation**,  
ebonite, 4, 435  
electrical, 1, 96-106, 185  
powders, by, 7, 228-230  
properties, 1, 101  
thermal, 1, 185  
and photochemistry, 7, 80  
at low temperature, 5, 465  
wire, of, 1, 96-97
- Insulators**, 1, 111, 267-269; 5, 559  
discovery, 4, 517  
for high frequency, 4, 172  
resistance and temperature, 4, 535
- Insulin film**, 10, 422  
molecular weight, 10, 416, 431  
over-dose, 9, 57  
X-ray diffraction, 10, 438
- Intensity**,  
absorption and concentration, of, 5,  
1-4  
change due to motion, 4, 197  
electricity, of, 1, 95-105, 365-369  
force, of, 1, 370  
Fraunhofer's lines, of, 8, 242  
infrared, 8, 237  
phosphorescence, of, 4, 375  
photography, and, 8, 236-238  
radiation, and, 8, 229  
sound, of, 8, 363-369  
measurement, 9, 289  
sunlight, of, 2, 13-14  
X-ray diffraction, of, 7, 452-453
- Interatomic forces**, 9, 79
- Interfacial angle**, 7, 120-134
- Interference**,  
acoustical, 4, 241; 8, 476-482  
bands,  
application, 4, 241-247  
photography, 4, 242-243  
Hertzian waves, of, 4, 20  
kaleidoscope, 4, 198  
light, natural, of, 9, 261-262  
motion, effects of, 4, 197  
polishing, use in, 5, 395  
principle, 3, 269  
sound, 4, 241; 5, 476-482  
telegraphy, 1, 435-441  
theory, 8, 517-518  
X-rays, of, 7, 445
- Interferential colour photography**, 4,  
480-484
- Interferential refractometer**, Jamin's,  
3, 323
- Interferometer**, 8, 239  
Michelson's, 4, 387
- Intermolecular**,  
distances, 9, 507-508  
forces, 4, 266; 10, 1-2  
demonstration, 3, 328-330  
gases, in, 4, 4  
range, 3, 327  
repulsive, 3, 132-133; 9, 79
- Internal**,  
combustion engine, 9, 104  
dispersion, 1, 84-89  
field, 6, 163-164  
friction, 6, 98  
motion of fluids, 4, 249  
reflection, total, 1, 132-133  
microwaves, of, 5, 18  
sound, of, 9, 286-287  
rotation, 9, 505-506
- International ohm**, 4, 521
- Internuclear forces**, 9, 8-10, 73-76
- Interstellar temperature**, 10, 94
- Interstitial space**, 7, 336
- Inulin**, 9, 80
- Invention**,  
air-pump, of, 2, 284-285  
barometer, of, 2, 284-285  
ophthalmoscope, of, 4, 394  
stereoscope, of, 4, 394  
thermopile, of, 3, 270-271  
Wheatstone's bridge, of, 4, 520

- Inverse squares, law of, 1, 68, 147, 230;  
8, 245; 9, 73  
gravity, 4, 350
- Inversion (*see also* Mutarotation)  
of cane sugar, 5, 498
- Invertebrates, carotenoids in, 10, 236
- Invisible,  
ink, 2, 424-425  
rays, 1, 88-89
- Iodine, 10, 332-355  
abundance, 10, 333-334  
atomic,  
heat, 5, 192; 7, 401  
radius, 8, 326; 9, 502  
refraction, 2, 541  
spectrum, 3, 125, 262  
volume, 7, 337, 401  
weight, 1, 500-508; 2, 541; 8, 340  
boiling of, 7, 470  
catalysis of,  
aluminium reactions, 2, 499  
phosphorous allotropy, 1, 57  
Chile saltpetre, in, 10, 334-335  
colour, 4, 263  
coral, in, 10, 336-337  
density, 6, 5-6  
discovery, 2, 316-317; 9, 94; 10,  
332-333  
dissociation, 3, 126  
evaporation, 2, 398  
filter for infrared work, 1, 532  
fluorine, action of, 5, 95  
green, 2, 189-190  
hydrogenised palladium, reduction  
by, 2, 47, 233, 239  
infrared absorption, 1, 493, 532; 8,  
284  
of solid, 2, 5  
ionic radius, 9, 86  
isotopes, 8, 339  
liberation, 1, 155  
light emission, 5, 27  
living organisms, in, 10, 335-344  
mass spectrum, 8, 337  
molecular spectrum, 3, 125  
multiple plates of, 8, 282  
occurrence, 10, 333-344  
potassium chemiluminescence, 9,  
220-221  
phosphorous glow, effect on, 4, 377  
photochemistry, 1, 202
- Iodine—*cont.*  
refractive index, 8, 275  
rock, in, 10, 334  
sea, in, 10, 334  
seaweed, in, 10, 335-337  
sodium chemiluminescence, 9, 220-  
221; 10, 389-390  
solution, in, 5, 195  
specific heat, 5, 192  
sponges, in, 10, 330-337  
starch indicator, 1, 22; 7, 70  
thermal expansion, 4, 463; 6, 5-6  
thyroid gland, in, 10, 336, 340-344  
ultraviolet,  
absorption, 1, 430-431  
spectrum, 3, 262  
vapour,  
density and temperature, 3, 126  
sound from, 3, 157  
spectrum, 3, 125  
volatility, 2, 400
- Iodic acid, 1, 333
- Iodides,  
atomic refraction, 2, 138  
oxidation kinetics, 2, 134-135  
viscosity, 5, 141-154
- Iodoacetic acid, 7, 198
- Iodobenzene-chlorine complex, 10,  
345-346  
infrared transmission, 8, 286
- Iodoform,  
colour, 6, 416  
density, 6, 5-6  
expansion, 6, 5-6  
pinacyanol from, 10, 130
- Iodonium compounds, 10, 353-354
- Iodoso-compounds, 10, 346-354
- Iodosobenzene, 10, 346-354  
acetate, 10, 347  
double-decomposition, 10, 347-348  
salts, 10, 347
- Iodoxybenzene, 10, 347-354  
hydrogen sulphate, 10, 349  
salts, 10, 349-352
- Iodoxylates, 10, 350-351
- Ionic atmosphere, 9, 410  
crystals, 8, 329-330; 9, 77-87  
diffusion, 6, 100  
equilibria, 6, 101  
miscelles, 9, 64-72  
radius, 9, 80, 86

**Ionic atmosphere—*cont.***

- reactions, 8, 26
- refractivity, 9, 81
- theory, 5, 559; 6, 90–103
- velocities (*see Ions, velocity*)

**Ionisation and chemical action, 6, 95–96**

- colour, 6, 99–100
- by cathode rays, 6, 327–344
  - $\alpha$ -particle, 6, 283; 8, 521
  - radiation, 5, 511; 7, 312
  - X-rays, 7, 506
- chamber, 7, 449
- degree of, 5, 486–487, 495
- detector, 7, 499
- of air by radium, 6, 42
- gases, 6, 17–23; 7, 100–103

**Ions, 4, 491; 5, 552**

- coagulative powers, 6, 188–189
- condensation by, 6, 64–66
- definition, 2, 73; 5, 558
- discharge in vacuum tube, 4, 284–285
- double salts, in, 5, 491
- electrolysis, in, 5, 483–499
- exchange, 10, 298–300
- flames, in, 7, 1–4
- independent migration of, 5, 493
- motion in gas, 8, 179–180
- positive, 5, 408; 6, 232–247, 314–344
- pressure, 3, 41–59
- stream diffusion of, 8, 180
- velocity, 5, 493–494; 6, 185–186
  - electric field, and, 8, 179–180
  - pressure, and, 8, 179–180

**Ionium, 7, 258–265**

- atomic weight, 8, 127–128
- discovery, 6, 280
- half-life, 6, 278; 8, 453, 457
- radiothorium, and, 8, 120
- spectrum, 8, 127
- thorium, and, 8, 120–128, 454
- uranium ratio in pitchblende, 8, 128

**Ionone, 6, 11–14****Ipeccicuana, 2, 242****Iridescent,**

- colour, 9, 261–262
- crystals, 3, 493–495

**Iridium,**

- atomic,
  - heat, 7, 401

**Iridium—*cont.*****atomic—*cont.***

- refraction, 2, 541
- volume, 7, 401
- weight, 2, 325
- bacteria, action on, 7, 86–92
- discovery, 2, 316–317
- platinum alloy,
  - at low temperature, 4, 231
  - resistance, 4, 525–527
- platinum thermocouple, 5, 240–241
- properties, 1, 352–353
- specific heat, 2, 325, 501
- synthesis, 10, 252–253

**Iris, oil of, 6, 11****Iron,**

- abundance, 7, 54; 10, 272
- alloys,
  - low temperature, at, 6, 425–426
  - study of, 5, 448
- alum, seeding by, 3, 399
- aluminium, in, 3, 503
  - alloys, 3, 508–509
- ammonium alum, 10, 92
- atomic,
  - heat, 5, 190–194; 7, 401
  - radius, 8, 326
  - refraction, 2, 541; 4, 212
  - spectrum, 1, 433; 3, 200–203; 7, 357–359
  - ultraviolet, 3, 258–265
  - volume, 7, 401
  - weight, 1, 500–508; 2, 325, 541; 5, 190
- bacteria, action on, 7, 86–92
- boiling point, 7, 237
- breaking stress, 4, 267
- carbon monoxide, reaction with, 4, 208
- carbonate,
  - Bath springs, in, 5, 158
  - magnetic field, in, 9, 136–137
  - paramagnetism, 1, 191
  - pressure, effect of, 9, 150
- carbonyl,
  - air, action of, 4, 213
  - alkali, action of, 4, 213
  - formulae, 4, 212
  - preparation, 4, 213
  - properties, 4, 213
  - sunlight, action of, 4, 214

**Iron—cont.**

- carborundum reaction, 8, 383
- calcium spectrum, 3, 189
- catalysis of carbon allotropy, 8, 294
  - combustion, 7, 406
- chloride, 1, 191
- citrate, 1, 221
- columbite, in, 7, 48
- comenamate, 1, 221
- cooling in magnetic field, 4, 141
- copper thermocouple, 3, 22–23; 5, 64–65
- earth's centre, in, 7, 55
- earth's crust, in, 7, 54; 10, 272
- eddy currents in, 3, 306–311; 4, 412–425
- effect on mutual inductance, 3, 302–304
- elasticity, 4, 270; 8, 360–361
  - and temperature, 5, 464
- electrodes, 7, 403
- electron diffraction, 9, 191
- emissivity, 8, 290
- filings in magnetic field, 1, 26; 8, 489–509
- finely-divided, 4, 213
- fluorine, reaction with, 5, 96
- friction, 4, 3
- gallate, 1, 129
- glass, in, 9, 155, 160–163
- heat conductivity, 6, 213; 7, 49
- heptacarbonyl, 4, 214
- hydrogen, diffusion through, 2, 45, 223–239
- hydroxide,
  - colloidal, 9, 194
- magnetic birefringence, 10, 165
- hysteresis, 4, 511
  - coefficient, 8, 508
  - and temperature, 4, 455–457
- induction heating, 4, 168
- lead thermocouple, 4, 538
- lines of force, and, 4, 7–8
- losses, 4, 136; 5, 12–15
- magnetic hysteresis (*see Iron, hysteresis*)
- permeability (*see Iron, permeability*)
- screening, 4, 96
- testing, 5, 452

**Iron—cont.**

- magnetism, 1, 191–195; 4, 320, 412–425; 9, 88
  - cyclic, 4, 424
  - heat, 4, 11–12
  - low temperature, at, 4, 541–548
  - soft, of, 1, 1
  - stress, and, 3, 18–20
  - under tension, 4, 137–140
- magneto-optical effects, 3, 517; 5, 175
- magnetostriction, 10, 460
- manganese alloy, 4, 525–529
- manganese silicate, 1, 331
- meconate, 1, 161, 220–221
- melting point, 7, 237
- mercury, amalgamation with, 8, 294
- meteorites, in, 2, 48, 233–239
- mordants, 3, 168, 170
- nature, in, 4, 240
- nickel alloy, 4, 525–529
- nitrogen preparation using, 4, 398
- occlusion of,
  - carbon dioxide, 2, 48, 233–239
  - hydrogen, 2, 48, 231–239
- oxalate, 4, 213
  - effect of light, 1, 261
- oxide, 1, 161
  - catalyst, 9, 331
  - magnetic, 1, 161, 528
    - field, in, 8, 489–509
    - seeding by, 3, 399
  - reaction with carbon monosulphide, 7, 152
  - reduction by hydrogen, 2, 150
- thixotropy, 10, 150, 163
  - and ultrasonics, 10, 163
- $\alpha$ -particle bombardment, 9, 15–16
- pentacarbonyl,
  - action of,
    - air, 4, 213
    - alkali, 4, 213
    - sunlight, 4, 214
  - preparation, 4, 213
  - properties, 4, 213
- permeability, 3, 284–285; 4, 8
  - and temperature, 4, 140, 542–545
- peroxide, 1, 95
- pigments in, 4, 235
- planes of force, 8, 506

Iron—*cont.*

- pressure in cooling, 7, 34
- pyrites, 1, 509
- crystal structure, 8, 319–323; 9, 82, 87
- lapis lazuli, in, 9, 163–164
- selenium in, 2, 467–468
- X-ray diffraction, 7, 453
- resistance and temperature, 4, 521–535; 5, 459
  - at low temperature, 4, 230
- rigidity, 8, 360
- salts,
  - double decomposition, 1, 20–21
  - magnetic susceptibility, 10, 85–98
  - magneto-optical effects, 3, 516
  - use in blue-prints, 4, 42
- saturation point, 3, 284
- sesquichloride, 1, 21
- silicate, 1, 331
- solar prominences, in, 3, 449–450
- specific heat, 2, 325; 5, 190–194
- spectrum (*see Iron, atomic spectrum*)
  - in steel, 1, 513
- structure and properties, 5, 448
- sulphate,
  - double, 5, 539
  - magne-crystals, 9, 141
  - magnetic susceptibility, 3, 285
  - paramagnetism, 1, 191
- sulphide,
  - allotropy, 1, 37
  - crystal structure, 9, 82, 87
  - magnetic field, in, 8, 495–509
  - seeding by, 3, 399
- sulphocyanide, 1, 128
- sulphuric acid, reaction with concentrated, 6, 96
- sun, in, 1, 358, 433
- tantalite, in, 7, 48
- temperature, diffusion through high, 7, 465–469
- thermal conductivity, 6, 213; 7, 49
- thin films, 3, 533–534
- thiocyanate, 1, 128
- trace in explosion, 3, 444–450
- ultramarine, in, 9, 164
- ultraviolet spectrum, 3, 258–265
- vacuum vessels, 6, 218
- vanadium in, 2, 124
- Villari effect, 3, 18–20; 4, 11

Iron—*cont.*

- X-ray,
  - formation of, 4, 504
  - target, 8, 50
- Young's modulus, 8, 354–355
- Zeeman effect, 6, 190
- Irone, 6, 11–12
- Ironing stoves, 2, 276
- Irreversibility, 4, 141; 6, 355, 358–359
- Isatin, 2, 266
  - formula, 3, 164
  - reduction, 3, 164
  - spectrum, 7, 359
  - structure, 7, 365
- Isatis tinctoria, 3, 159
- Isinglass, 1, 250
- Isoamyl alcohol, 10, 115–116
- Isoamylene, 5, 141–154
- Isobare, 8, 339–341
- Isobutane, 2, 481, 486
  - synthesis, 2, 489–492
- Isobutyl,
  - alcohol, 2, 483, 486
  - viscosity, 5, 141–154
- bromide, 5, 141–154
- chloride, 5, 141–154
- hindrene, 6, 13
- iodide, 5, 141–154
- toluene, 6, 13
- xylene, 6, 13
- Isobutylene dibromide, 5, 141–154
- Isobutyric acid-water opalescence, 9, 275–276
  - viscosity, 5, 141–154
- Isocyanates, 7, 202
- Isocyanine dyes, 10, 130–141
- Isoelectric points in muscle, 5, 421
- Isoheptane, 5, 141–154
- Isohexane, 5, 141–154
- Isolactose, 6, 38
- Isolation of gases, 6, 226–228
- Isomerism, 1, 37, 55
  - dynamic, 7, 382
  - heat evolution, and, 1, 56
  - metal compounds, of, 5, 195–196
  - oil of turpentine, of, 1, 56
  - paraffins, of, 2, 481–482
  - refraction, and, 6, 161
  - spectra, and, 7, 365–366
- Isomers, 2, 481–482
  - discovery, 6, 25

**Isomers—*cont.***

- optical, 6, 29–39
  - resolution, 6, 32–34
  - spectra, 7, 364
- Isomorphism, 2, 500
  - and seeding, 3, 397–402
- Isopentane, 2, 482, 486
  - synthesis, 2, 489–492
  - viscosity, 5, 141–154
- Isopentyl alcohol, 2, 484, 486–487
- Isoprene, 10, 237
  - infrared transmission, 8, 285
  - viscosity, 5, 141–154
- Isopropyl,
  - alcohol, 2, 485
    - infrared transmission, 8, 286
    - viscosity, 5, 142–154
  - bromide, 5, 141–154
  - chloride, 2, 485
    - viscosity, 5, 141–154
  - iodide, 5, 141–154
  - zinc, 2, 448, 498
- Isosafrol, 6, 13
- Isosynchronous motion, 2, 292–293
- Isotherms,
  - ether, for, 4, 107–109
  - water, for, 4, 106–108
- Isotopes, 8, 113–135, 332–342, 449–461; 10, 15–27, 45–70
  - atomic theory, and, 8, 332
  - atomic weight, and, 8, 114
  - artificial, 10, 109–110, 254
  - chemical identity, 8, 113–114
  - definition, 8, 133, 333; 10, 48–52
  - effects, 10, 19, 60–70
    - and uncertainty principle, 10, 49–57
  - exchange reactions, 10, 19, 60–66
  - hydrogen, of, 10, 15–27, 50
  - labelling by, 10, 68–70
  - lead, of, 8, 120–126
  - neon, discovery of, 7, 296
  - nucleus, and, 8, 114
  - production, 3, 421
  - separation,
    - diffusion, by, 8, 129–130
    - hydrogen, of, 10, 18–21, 49
    - mercury, of, 8, 339
    - oxygen, of, 10, 68–69
  - substitution, 10, 63–64
  - theory, 8, 459–461

**Isotopes—*cont.***

- X-ray spectra, 8, 114
- Isotropic,
  - elasticity, 8, 346
  - solids, 3, 60–62
- Isovaleronitrile, 8, 288
- Ivory,
  - elasticity, 4, 270
    - and temperature, 5, 464
  - phosphorescence, 4, 377; 5, 464; 7, 81

**J**

- Jack, hydraulic, 7, 29
- Jamin's interferential refractometer, 3, 323
- Janssen's law of absorption, 5, 1–2
- Jargons, 9, 165
- Jasmine oil, 6, 11, 13
- Jean's fish-net hypothesis, 8, 108–109
- Jelly (*see also Gel*)
  - fish fossils, 10, 157
  - gold-containing, 1, 250
  - motion, 4, 248
  - nitrogen, 4, 460
  - soap, 9, 71
- Jena glass,
  - catalysis by, 7, 102
  - works, 5, 444–447
- Jet apparatus,
  - attraction of concave surface, 7, 438
  - ball supported on, 5, 278; 7, 437
  - films, for, 8, 413–414
  - hydrogen, 4, 476
  - interactions, 1, 131
  - liquid hydrogen in, 5, 255
  - liquid in gas, 4, 463–466
  - smoke, of, 4, 278–279
  - soap, of, 8, 423–433
  - water, of, 4, 34–35
- Joachimstahl,
  - lead from, 8, 126
  - pitchblende, 5, 512
- Joly's calorimeter, 5, 193
- Joule,
  - atomic volume measurements, 4, 4
  - calorie, and, 4, 1–6
  - character, 4, 5–6
  - Playfair's reminiscences, 4, 5–6

**Joule—cont.**

- Royal Society, and, 4, 5–6
- scientific work, 4, 1–6
- specific gravity measurements, 4, 4
- Thompson effect, 4, 4; 5, 363; 6, 356
- water density, study of, 4, 4

**Junction, electrolytic, 6, 186****Jupiter,**

- orbit, 8, 226
- photographs, 1, 260

**Jute, 5, 23**

- fibres, 9, 246

**K****K-radiation, 7, 491, 505–506, 511****Kaemferol, 9, 116****Kairine, 3, 370**

- constitution, 3, 370
- discovery, 3, 370
- price 1886, 3, 370
- synthesis, 3, 370

**Kakodyl, 1, 477****Kaleidoscope, interference, 4, 198****Kaliophyllite, 9, 452–454****Kanalstrahlen, 6 314–344**

- discovery, 6, 232
- mass-charge ratio, 6, 232

**Kaolinite,**

- structure, 10, 288–290
- X-ray diffraction, 10, 290

**Kekulé structure, 6, 159–160****Kelvin, 6, 345–380**

- aether, and the, 6, 373
- ammeters and voltmeters, 6, 376
- atmospheric electricity, 6, 372–373
- dynamoes, 6, 376
- economics of power transmission, 6, 375–376
- electric motors, efficiency of, 6, 376
- electrical engineering studies, 6, 375–377
- electricity, domestic, 6, 376
- energy, sources of, 6, 375
- intellect, 6, 345–346
- life, 6, 347–348
- Niagara Falls, 6, 375
- publications, 6, 346–347
- radiation, 6, 373–375

**Kelvin—cont.****radiation—cont.**

- views on, 6, 359
- scale of temperature, 6, 349; 10, 71–72
- ship's compass, 6, 372
- ship's soundings, 6, 372
- spin, concept of, 6, 389
- sun's energy, utilisation of, 6, 361
- tides, calculation of, 6, 372
- treatise on natural philosophy, 6, 367–368
- waves, 6, 373
- work on,

- animal thermodynamics, 6, 361
- angular momentum, 6, 368–369
- cell thermodynamics, 6, 360–361
- energy, 6, 348–360
- entropy, 6, 354–355
- gas expansion, 6, 356
- gyroscope, 6, 369
- magneto-optics, 6, 371
- magneto-thermodynamics, 6, 361–363

- telegraphy, 6, 366–367
- thermodynamics, 6, 348–360
- thermoelectric effect, 6, 354
- vortex atoms, 6, 371
- Zeeman effect, 6, 371

**yachting, 6, 371–372****Kepler's laws, 4, 350–374**

- second law, 8, 228
- third law, 8, 224

**Keratin, 9, 447, 455**

- molecular structure, 10, 216–217
- sulphur content, 10, 217

**Kerr's experiment, 3, 479****Keptones,**

- infrared transmission, 8, 283–286
- phosphorescence, 4, 377–378
- secondary alcohols, from, 2, 485
- viscosity, 5, 131–154
- X-ray diffraction, 9, 41–47

**Kew, 2, 13–15****Kieselguhr, 7, 239****Kilogramme, standard, 10, 15****Kinematic viscosity, 7, 439****Kinetics,**

- adsorption on charcoal, 6, 251–254
- carbon monoxide combustion, 8, 468–488

**Kinetics—*cont.***

- chemical, 1, 18–21; 2, 132–135; 3, 544; 8, 26; 10, 391–402
- chemiluminescence, and, 9, 217
- chlorine photochemistry, 1, 203–204
- combustion, 2, 132–133
- diffusion in liquids, 1, 393–396
- energy, 1, 199, 371–372, 414
  - earth, of, 1, 417–418
- evaporation, 2, 398–404
- explosions, 4, 142–149
- gas, 10, 384–403
- hydrogen combustion, 8, 468–488
- ionic reactions, 8, 26
- isotope effects, 10, 19, 66–67
- mutarotation, 7, 383
- polymerisation, 10, 261–262
- theory,
  - development, 5, 362–363
  - elasticity, of, 3, 136–137
  - gases, of, 3, 38–40, 122–137, 227–256; 5, 329–358; 7, 169–171; 8, 346
  - heat, of, 1, 196–201
  - liquids, of, 7, 169–171
  - radioactivity, of, 7, 154–163
  - spectra, and, 8, 237
  - viscosity, of, 7, 170
- Kite, 5, 294
  - Franklin's experiment, 1, 334
- Kitchen furnaces, 2, 276
- Klangfarbt, 2, 24
- Knife-edges, 8, 296
- Koalinisation, 4, 57
- Kohlrausen's law, 5, 493
- Kolbé electrolysis, 1, 271; 8, 344–345
- Korner principle, 10, 117
- Korpolite, 1, 331
- Kryptocyanine ethioidide, 10, 135
- Krypton, 9, 313
  - air, in, 8, 466–467; 6, 435
  - argon ratio, 7, 462
  - atomic,
    - radius, 8, 329
    - spectrum, 5, 470
    - structure, 8, 226
    - weight, 5, 467; 7, 71; 8, 340
  - boiling point, 7, 71
  - density, 5, 467
  - discovery, 5, 466–467
  - electronic structure, 8, 327

**Krypton—*cont.***

- glow discharge, 5, 468
- isolation, 6, 228
- isotopes, 8, 336–340
- mass-charge ratio, 7, 295
- mass spectrum, 8, 336–340
- melting point, 7, 141
- ratio of heat capacities, 5, 335
- xenon ratio, 7, 462
- Kryptoxanthin, 10, 234
- Kuebelite, 1, 331
- Kundt's tube, 9, 304–311
- Kunzite, 9, 222
- Kyanol, 2, 185

**L**

- L radiation, 7, 491, 505–506
- Labelling by isotopes, 10, 68–70
- Labradorite, 5, 22
- Lactase, 6, 37
- Lactic acid, 1, 75, 274, 521
  - formula, 1, 575
- Lactose, 4, 48
- Ladenberg structure, 6, 159–160
- Lagging, 7, 239
- Lagrangian coordinates, 5, 332
- Lakes, cosmic rays in deep, 10, 31
- Lamellar crystals of soap, 9, 66–72
- Laminar flow, 3, 295–297
- Laminated core, 4, 412
- Lampblack, 6, 107
  - infrared absorption, 1, 390
  - insulation, 5, 162–164
- Lamp, 2, 276
  - cathode ray, 5, 102–103
  - Dobereiner, 7, 406
  - electric, 1, 246; 7, 46
  - lighting by Tesla coil, 4, 179
  - mercury, 7, 83, 372–377
  - osmium, 7, 47
  - safety, 6, 299
  - sodium, 10, 387
  - spectrum, 7, 356
  - Swan, 4, 342
  - thermionic emission, 7, 492
- Lanthanum,
  - atomic,
    - heat, 7, 401
    - refraction, 2, 541



**Lanthanum—cont.****atomic—cont.**

volume, 7, 401

weight, 1, 500–508; 2, 541

discovery, 2, 316–317

**Lapis lazuli**, 9, 163–164**Laplace's equations of motion**, 8, 189**Laquer, black**, 3, 363**Larkspur**, 9, 115**Latent heat of,**

adsorption by charcoal, 6, 384, 402

evaporation, 2, 398–404; 6, 77

crystals, of, 9, 79

liquefied gases, of, 4, 264

fusion of ice, 1, 253–254

**Lattice, space-**, 7, 330**Laudanin**, 7, 367**Laudanosin**, 7, 367**Laues equations**, 7, 345**Laundries**, 2, 276**Laural oil**, 7, 380**Lauric acid**, 1, 546**Lava**, 3, 299**Lavender,**

absorption spectrum, 1, 222–223

oil, 6, 11

action on photographic plate, 5,  
259**Law,****Avogadro's**, 6, 91; 7, 171–172**black-body radiation**, 8, 106**Bode's**, 8, 224**chemical combination**, of, 1, 74**colour**, of, 1, 241–245**conservation of,**

energy, of, 1, 370–380

force, of, 1, 370–380

zones, of, 1, 297

**Curie's**, 10, 85, 89**definite proportions**, of, 1, 18**diffusion of gases**, of, 2, 224**distribution of velocities**, of, 7, 497–  
498**Dulong and Petit's**, 7, 391–401; 8,  
103**dynamical similarity**, 7, 440–444**electrical conduction**, 4, 518**electrolysis**, 1, 365; 2, 73–75; 9,  
397–405**equipartition of energy**, 5, 329–358**exchanges**, 4, 200**Law—cont.****fluorescence**, Stokes, 9, 184**gas**, 8, 346**gravitation**, 4, 350–374; 5, 296**Henry's**, 7, 473**inverse squares**, 1, 68, 147, 230; 4,  
350; 8, 73, 245**Kepler's,**

second, 8, 224

third, 8, 228

**Lenz's**, 8, 509**mass action**, 7, 248**Moseley's**, 8, 227**multiple proportions**, 6, 90**osmosis**, of, 7, 6**Planck's radiation**, 8, 276**radioactive change**, 8, 132**radiation**, of, 5, 236–240; 8, 271–  
278

pressure, 6, 151

**Raoult's**, 7, 13–15**rarefaction**, 7, 172**rational indices**, 7, 333**reflection**, of, 5, 18**refraction**, 8, 511–512**Snell's**, 8, 511–512**Stephan's fourth power**, 8, 271–272**Stokes',** 7, 176**third of thermodynamics**, 10, 97**Widdington's**, 8, 57**Wien's**, 8, 240, 277–278**Layer, Bulby**, 10, 250**Lead,****abundance**, 10, 272**acetate,**reaction with carbon monosul-  
phide, 7, 152

test for hydrogen sulphide, 2, 355

**atomic,**

heat, 5, 190–191; 7, 401

refraction, 2, 541

volume, 7, 401

weight, 1, 500–508, 535; 2, 325,  
541; 5, 190; 8, 124–135,  
333–334**bacteria, action on**, 7, 86–92**bismuth alloy**, 9, 424**borate in glass**, 2, 56–57**borate magnetism**, 1, 68**borosilicated**, 9, 104**breaking stress**, 4, 269

**Lead—cont.**

- carbonate,
  - basic, 1, 332
  - infrared absorption, 2, 5
- chloroarsenate, 2, 127
- chlorophosphate, 2, 127
- chlorovanadate, 2, 127
- combustion, 2, 287–288
- density, 8, 125
- dioxide, 1, 142
- eddy currents in, 3, 306–311
- effect on mutual inductance, 3, 304
- elasticity, 4, 270
  - and temperature, 5, 464
- electrical conduction of fused, 1, 30
- electrochemical equivalent, 9, 401
- electrochemistry, 8, 122
- emissivity, 8, 290
- expansion coefficient, 4, 462
- flow, 6, 7
- fluoride, 5, 89
- glass, 2, 56–57; 4, 158; 9, 104, 132
  - copper in, 9, 156
  - ferric oxide in, 9, 161
  - magneto-optical effect, 2, 84–88; 5, 170–188
  - phosphorescence, 4, 492
  - X-ray absorption, 4, 487
- gold alloy, 9, 424–425
- gravitational effects, 5, 305
- half-life, 6, 278
- hydraulic fluid, as, 7, 27–29
- ionic radius, 9, 86
- isotopes, 8, 134, 457; 10, 47
- light absorption and temperature, 9, 431–432
- melting point, 7, 237
- monazite, from, 8, 126
- nitrate, basic, 1, 333
- occurrence, 2, 125–126
- orthophosphate, 2, 502
- orthovanadate, 2, 502
- oxidation by ozone, 1, 23
- oxide in glass, 9, 156
  - infrared absorption, 2, 5
  - insulation, 5, 164
- peroxide, 1, 282
- phosphate, 2, 502
- photoelectric effect, 9, 431–432
- photography, action on, 2, 257–258
- pitchblende, from, 8, 126, 134

**Lead—cont.**

- platinum alloy, 1, 353
    - thermocouple, 4, 537–539
  - proton bombardment, 9, 498
  - pyrophosphate, 2, 502
  - pyrovanadate, 2, 502
  - radioactive, 8, 120–122
  - radium, and,
    - B, 7, 506
    - C, from, 8, 133
    - D, 8, 120–123, 454
  - ratios, 8, 112
  - $\beta$ -ray absorption, 9, 430–431
  - $\gamma$ -ray absorption, 7, 505
  - reflection of ultraviolet light from, 1, 431
  - resistance and temperature, 4, 524–527
  - screening by, 4, 100
  - silver phase behaviour, 2, 525–526
  - specific heat, 2, 325; 5, 190–191; 6, 87
  - spheres, 4, 359–360
  - sun, absence from, 1, 359
  - superconductivity, 9, 424–425; 10, 74–75
  - surface tension of liquid, 4, 118
  - tetraethyl, 1, 536
  - thermal conductivity, 6, 213
  - thermocouples, 4, 538–539
  - thorium, from, 8, 124–126
    - C, 8, 133
  - thorite, from, 8, 125, 134
  - trace in explosion, 3, 445–450
  - tree, 2, 335, 338
  - ultraviolet spectrum, 3, 266
  - uranium, from, 8, 124–126
    - minerals, 8, 126, 134
  - vanadate, 2, 502
    - occurrence, 2, 124
  - vibrations from, 1, 107–110
  - X-ray,
    - absorption, 8, 52–54
    - spectrum, 8, 123
    - target, 8, 50
  - Young's modulus, 8, 354–355
- Leaf,**
- colour, 9, 18–25
  - diffusion of carbon dioxide through, 5, 372–381
  - silicon in, 7, 61

- Leaf**—*cont.*  
 stalk, 5, 423–424  
 structure, 5, 372  
 transpiration of water, 5, 372–373  
 xanthophyll, 10, 234
- Leakage**, magnetic, 4, 87
- Least action**, 5, 565
- Leather**, 4, 377; 5, 463
- Leclanché cell**, 3, 94
- Lecithine**, 10, 155
- Leffman-Bean method**, 5, 452
- Lemon**,  
 grass oil, 6, 12  
 oil, 1, 37; 6, 12  
   action on photographic plate, 5, 259  
   extinction of phosphorous glow, 4, 15  
   magnetism, 1, 68  
   optical activity, 3, 516; 7, 380
- Lenard rays**, 5, 46–48  
 properties, 4, 502
- Length**,  
 measurement, 5, 556  
   and optics, 3, 229  
   molecules, of, 9, 227  
   relation to mass and time, 4, 429  
   relative axial, 7, 350  
   sodium standard, 4, 429  
   spark and electrode material, 3, 107–108  
   effect of rays, 4, 502
- Lens**,  
 achromatic, 1, 122  
 calcite, 8, 316  
 construction, 6, 125  
 Hertz waves, effect on, 4, 347  
 microwaves, for, 5, 16  
 object, 1, 122–123  
 quartz, 8, 316  
 sodium chloride, 1, 530  
 sound, 3, 464–465
- Lenz's law**, 4, 100; 8, 509
- Lepidine**, 10, 135–137
- Leslie's cube**, 5, 393; 8, 253–259  
 thermometer, 6, 229  
 work on heat, 3, 268–269
- Leucic acid**, 1, 519–520
- Leuco-compound**, 5, 537
- Leucoline**, 1, 400
- Lever**, optical, 8, 208
- Leyden**,  
 battery, 1, 173–176  
 jar, 3, 217  
   air, effect of, 4, 177  
   bursting, 3, 488–489  
   capacitance, 3, 94  
   discharge, 3, 481–495; 7, 278–285
- Lichen**, 10, 339  
 colours from, 9, 24
- Life and films**, 9, 109  
 at low temperatures, 6, 437  
 origin, 2, 304; 4, 222; 6, 35  
 Tyndall's work, 4, 281
- Lifting jack**, hydraulic, 7, 29
- Lifting-power of magnet**, 4, 9
- Light**,  
 aberration, 5, 325; 8, 101  
 absorption, 1, 84–89, 219–226, 242  
   atmosphere, by, 1, 422–426  
   concentration, and, 7, 360–362  
   emission, and, 3, 63  
   resonance, and, 3, 123  
   temperature, and, 4, 378; 9, 431–432  
   transmission, and, 1, 219–226  
   theory, 1, 385–389
- azides**, action on, 7, 204
- application of polarised**, 7, 371–384
- arc**, 7, 46
- bleaching effect**, 1, 257
- chemical action**, 1, 202–204, 319–326; 2, 275
- chlorine**, effect on, 1, 261
- circularly polarised**, 2, 357–361
- combination tones**, 10, 404–413
- corpuscular theory**, 8, 510–515; 9, 4–5
- deflection by mass**, 8, 214–215
- diffraction**, 3, 454
- dispersion**, 1, 84–89  
   by crystals, 1, 293–304
- dual nature**, 8, 510–519
- dynamical theory**, 5, 324–358
- electrolysis**, effect on, 3, 8–10
- energy**, 1, 200–201
- epipolised**, 1, 84–89
- filters**, 5, 253–254
- flint glass**, 9, 161
- fluid theory**, 1, 29
- heat**, analogy with, 1, 42–48; 2, 320–324; 3, 271–272

**Light—cont.**

- intensity from flame, 1, 360–364
- interference, natural, 9, 261–262
- iron oxalate, effect on, 1, 261
- lighthouse, from revolving, 4, 192
- lime, 1, 5, 220
- magnesium, emission by burning, 1, 514–515
- magnetisation, 2, 331–334
- mass, 8, 192
- mechanical action, 2, 442–465
- medium motion, effect of, 4, 201
- molecules, effect on, 1, 256–262
- momentum, 8, 514
- nitrogen, emission by active, 7, 306
- origin, 3, 271–272
- perception, 1, 241
- photoelectric effect, 9, 182–192
- photography of scattered, 8, 312–313
- plants, effect on, 1, 257
- polarisation, 1, 4–8; 2, 168–177, 271–274, 331
  - clouds, by, 2, 169
  - crystals, by, 1, 298–304
  - gold leaf, by, 1, 250–251
  - model, 3, 518–522
  - scattered, of, 2, 172–177; 3, 248–249
  - tourmaline, by, 2, 168–169
- polarised, 1, 270; 2, 84–88, 393–397; 5, 170–188
  - astronomy, in, 2, 393
  - colour, and, 2, 405–410
  - crystals, and, 1, 256
  - discovery, 2, 168
  - rotation by quartz, 2, 271–274
  - theory, 2, 272–274
- pressure, 2, 9; 6, 419; 8, 192
  - and relativity, 8, 575
  - explanation of Crookes' experiment, 3, 40
- quanta, 8, 515
- quantum-electron collision, 9, 5
  - theory, 8, 510–519; 9, 4–5, 201–206
- receiver and source motion, effect of, 4, 201
- reflection, 1, 5, 242; 2, 332
  - from magnet, 3, 533–534; 5, 176–177
- refraction, 1, 84–89, 122; 2, 331–334

**Light—cont.**

- relativity theory, 9, 201–204
- Rumford's work, 2, 276
- scattering, 2, 156–177; 9, 268–280
  - air, by, 2, 254–264
  - gold sols, by, 1, 215–218, 249–251; 2, 21
  - liquids, by, 9, 272–273
  - molecules, by, 2, 261; 7, 98–99; 8, 311–317; 9, 270–280
  - particles, by, 2, 254–264; 8, 308–309; 9, 269–270
  - Rayleigh's law, 3, 431
  - sulphur, by, 3, 247
  - theory, 2, 261; 3, 248–250; 7, 97
  - Tyndall's work, 4, 280–281
  - water, by, 2, 254–264
  - wavelength, and, 9, 214
- selenium, action on, 2, 466–477
- sensation of, 2, 123
- size of quanta, 8, 578–579
- sky, from polarisation, 8, 309
- sound, analogy with, 1, 305; 2, 1–6
- source, 7, 371–378
  - for projection, 4, 184
  - in flame, 2, 151–155; 5, 27–35
- sun, from, 2, 331
- theory, 1, 42–48, 59; 2, 7–12, 156–177
  - interference, of, 8, 517–518
  - propagation, of, 1, 346
  - refraction, of, 3, 239
- transmission by,
  - gold leaf, 1, 215–218, 249–251; 2, 21
  - magnetised solutions, 1, 38
- ultraviolet, 1, 88–89; 4, 27–34
  - coal-gas flame, from, 1, 427–428
  - sun, from, 2, 13–21
- velocity, 1, 241; 2, 7–12, 381, 435–438, 477; 9, 224
  - colour, and, 3, 240
  - crystals, in, 5, 541–550
  - flowing water, in, 4, 198
  - media, in, 3, 239
  - Michelson's work, in, 4, 202
  - refractive index, and, 3, 239
  - theory of, 3, 240–247
  - water, in, 2, 10
- wave theory, 1, 257; 3, 123, 227–256, 454, 462; 8, 570–571; 9, 4–5

**Light—cont.**

- wavelength and frequency, 3, 229
- determination, 3, 247

**Lighthouse, revolving, 4, 192****Lighting,**

- film-making, for, 10, 133–134
- gas, 7, 46
- ships, of, 4, 97

**Lightning, 1, 334–347**

- calculation of voltage, 3, 100
- cascade effect, 3, 101
- conductors, 3, 485; 4, 322
- discharges, 4, 176

**Lime, 1, 284–289**

- catalysis by, 7, 102
- cathode, 6, 167; 7, 36–37
- distillation of benzoic acid with, 9, 99
- glass, in, 9, 157
- hydrate with baryta, mixed, 1, 128
- light, 1, 5, 220; 3, 142
- for projection, 4, 184
- sound from, 3, 154–155
- ultraviolet,

- emission, 1, 428
- spectrum, 3, 261

- melting point, 7, 237
- oxygen preparation, use in, 1, 94
- softening water, use in, 2, 262–264
- sulphur trioxide reaction, 7, 100
- volcanic, 9, 96
- water, 2, 263

**Limekilns, 2, 276****Limestone effect of,**

- pressure, 8, 291–292
- temperature, 8, 291–292

**Limit of,**

- atomic vibrations, 7, 509–511
- elasticity, 8, 361
- refrangibility, 1, 435

**Limiting thickness of liquid films, 3, 234–237****Limits explosion, 9, 466–467****Limonene, 6, 12**

- nitroschloride, 7, 202

**Linalool, 6, 10, 12**

- Linde method, 6, 383

**Line**

- broadening and temperature, 3, 443
- first mean, 1, 298–304
- shapes, spectral, 8, 236–243

**Line—cont.**

- shifts, spectral, 3, 132
- spectra, quantum theory, 8, 108–109

**Linen,**

- bleaching, 2, 267
- phosphorescence, 4, 377; 5, 464
- water absorption, 2, 278

**Lines,**

- force, of, 1, 59–63, 227–240; 2, 101–147, 372–382; 4, 7–12
- electric, 1, 268–269; 4, 95
- magnetic, 1, 64–75; 9, 139
- Fraunhofer's, 1, 357–359, 385–389, 432; 2, 164; 3, 63, 179, 260–262
- intensity, 8, 242
- transmission, 1, 99–105

**Linseed oil,**

- action on photographic plate, 5, 259
- magnetism, 1, 68

**Lipase, 8, 29–30****Lipochromes, 10, 227–243****Liquefaction,**

- air, of, 4, 219
- demonstration, 4, 232
- in sealed flasks, 4, 461–462
- ammonia, 9, 98
- apparatus, 4, 469, 471
- demonstration, 3, 312–314
- chlorine, 2, 55–56; 4, 158
- dioxide, 9, 98
- cyanogen, 9, 98
- fluorine, 5, 465–466
- gas jets, in, 4, 463–466
- gases, 2, 49, 294–301; 3, 21–27; 4, 160–161; 5, 359–368
- by Faraday, 2, 55–56; 9, 98
- history, 5, 282–283
- helium, 5, 472; 9, 314–315
- hydrogen, 5, 207–208, 485–488
- chloride, 9, 98
- in jet, 5, 205
- sulphide, 9, 98
- nitrous oxide, 9, 98
- oxygen, 4, 218
- sulphur dioxide, 9, 98
- temperature comparison, 4, 472

**Liquefied gases, 3, 312–317**

- convection losses, 4, 223–224
- demonstration, 5, 313
- infrared transmission, 4, 259

**Liquefied Gases—*cont.***

- latent heats, 4, 264
- radiation losses, 4, 223–226
- storage, 4, 223–229

**Liquid,**

- air, 4, 223–234, 457–478; 6, 210–231
  - absorption spectrum, 5, 3–4
  - alcohol on, 4, 234
  - applications, 5, 158–169
    - in phosphorescence, 4, 375–378
  - bacteria, effect on, 5, 470–471
  - bubbles from, 8, 69–77
  - calorimeter, 6, 78–81, 430; 7, 232–234
  - density, 4, 463
    - measurement, 6, 1–2
  - dielectric constant, 5, 462
  - drops, 7, 230–232
  - evaporation, 4, 221, 232–233
  - fractionation, 6, 383
  - heat transmission, 5, 465
  - ionisation by radium, 5, 512
  - microwave transparency, 5, 18
  - photographic effects, 4, 378–380
  - radioluminescence, 6, 41
  - refractive index, 4, 259; 8, 275
  - separation of gases, 5, 155–161
  - solubility of gases in, 5, 468
  - spheroidal state, 5, 155; 6, 211
  - thermoscope, 8, 253–270
  - use in conductivity measurements, 4, 518–535
  - uses, 4, 258–272
  - X-ray absorption, 5, 160
- carbon dioxide, 6, 5,
- chlorine, 3, 21–22
- crystal, 7, 121, 331; 9, 511–550
  - cholesteric, 9, 543–546
    - liquid transition, 9, 512–515, 536
  - nematic, 9, 536–543
  - smectic, 9, 514–536
  - soap, of, 9, 65–72
    - solid transition, 9, 516, 536
- definition, 6, 67–68
- droplets, 4, 119
- ethylene flame calorimeter, 4, 470
- films, 3, 318–324; 8, 136–178; 10, 446–457
  - colours, 8, 1, 23–26
  - limiting thickness, 3, 234–237
- fluorine, reactions, 6, 425

**Liquid—*cont.*****helium,**

- conduction in, 7, 234
- density, 9, 315
- entropy, 10, 464
- expansion, 10, 463–464
- fountain effect, 10, 465–468
- heat conduction, 10, 464–467
- levelling effect, 10, 469–473
- phases, 10, 464
- properties, 10, 463–477
- second sound, 10, 477
- superconductivity in, 8, 216; 9, 419–495
- theory, 10, 474–477
- viscosity, 10, 468–469
- X-ray diffraction, 10, 473–474
- hydrogen, 5, 198–199, 282–292
  - apparatus, 5, 463
  - applications, 5, 365–368
  - calorimeter, 6, 74–89, 430; 7, 392–401
  - drops, 7, 230–232
  - fluorine reaction with solid, 6, 424
  - photography at temperature of, 6, 424
  - production of vacua, 5, 285
  - properties, 5, 458–459
- jets, interaction, 1, 131
- liquid crystal transition, 9, 512–515, 536
- nitric oxide, 4, 462
- nitrogen, 4, 463
- oxygen,
  - air, removal from solid, 4, 460
  - chemical properties, 5, 465
  - combustion in, 4, 463
  - density, 4, 462; 6, 1–2
  - dielectric constant, 5, 462
  - magnetic properties, 4, 218–222; 5, 4–10
    - susceptibility, 5, 4–10
  - production, 6, 383
  - properties, 5, 1–10, 454–455
  - transformer core, 5, 5–10
  - use in conductivity measurements, 4, 518–535
- ozone, 7, 135–137
- phase photometers, 3, 8–10
- solid critical point, 2, 301; 7, 26

**Liquid—cont.**

- spectra, 3, 124
- state, 2, 294–301; 4, 104–113
- surface,
  - hemispherical, 3, 346
  - molecules on, 9, 1–2
  - properties, 3, 318–324
- thermometer, 2, 344
- volumes, 7, 169

**Liquids,**

- absorption of gases by, 2, 200, 209
- anisotropic, 9, 65–72
- boiling, 1, 131–133
- capillary tube, passage through, 2, 211–213
- coherence, 8, 347
- compressibility, 7, 18; 9, 273
- critical velocity, 3, 298–299
- diffusion, 2, 213–215; 7, 167
  - of salts in, 1, 393–396
- through rubber, 7, 483–486
- electrical stress, 3, 478–480
- electrolysis, 6, 183–189
- electrolytic resistivity, 4, 518
- evaporation, theory of, 7, 493
- foaming, 4, 26–38
- gas, and, 4, 104–113
- gas jets, in, 4, 463–466
- infrared,
  - absorption, 1, 466, 492–493
  - spectra, 3, 207–215
- ionisation by radium, 5, 512
- light scattering, 9, 272–273
- magnetic susceptibility measurement, 5, 4–10
- motion of, 1, 131–133 (*see also Hydrodynamics*)
- opalescence, 9, 275–276
- palladium, absorption by, 2, 47, 233–239
- powders, 3, 479
- refraction, 1, 132–133
- shear, 8, 346
- shearing birefringence, and, 9, 168–169
- sound and heat experiments, 3, 152
- structure, 9, 323–324
- superheating, 4, 110
- surface viscosity, 3, 318
- transmission of heat, 2, 275–281

**Liquids—cont.**

- transpiration, 2, 211–213
- viscosity, 2, 211–213; 3, 290–299; 5, 135–154; 9, 168
- X-ray diffraction, 9, 323–324
- Lissajous figures, 1, 247–248; 4, 387
- Lithia, 1, 284–289
- Lithium, 1, 284–289
  - atomic,
    - heat, 7, 401
    - radius, 8, 326; 9, 502
    - refraction, 2, 541
    - spectrum, 1, 354–359, 384; 3, 75–77, 133, 186–203, 441–443; 8, 35–36
    - structure, 8, 221
    - volume, 7, 401
    - weight, 1, 500–508; 2, 325, 541
- Bath springs, in, 5, 159
- bombardment by,
  - deuterons, 10, 22–23, 109
  - protons, 9, 496–497; 10, 22–23
- carbonyl, 4, 208
- colour test for, 1, 354–355
- combination series, 8, 35–36
- chloride,
  - depression of freezing point, 6, 97–98
  - solution conductivity, 6, 95
- crystal structure, 8, 330
- deuteron bombardment, 10, 22–23, 109
- diffuse, 8, 35–36
- discovery, 2, 316–317
- electrodes, 7, 403
- electron diffraction, 9, 191
- fluoride, 8, 330–331
- fundamental series, 8, 35–36
- hydroxide, 6, 97–98
- ionic radius, 9, 86
- mercury,
  - methyl, 1, 518–522
- oxide, 9, 159, 161
  - in glass, 9, 161
- $\alpha$ -particle bombardment, 9, 15–16
- permanganate, 6, 100
- platinocyanide, 4, 377–378
- potassium sulphate, 9, 85–87
- principal series, 8, 35–36
- production, 1, 287
- properties, 1, 287

**Lithium—*cont.***

- proton bombardment, 9, 496–497; 10, 22–23
  - recoil, 8, 246–250; 9, 415
  - sharp series, 8, 35–36
  - silicate, 1, 331
  - specific heat, 2, 325
  - Stark effect, 8, 239
  - steel, in, 1, 513
  - sulphate, 6, 94
  - test for, 1, 287–288
  - trace in explosion, 3, 442–450
  - ultraviolet spectrum, 3, 259, 266
  - X-ray transparency, 4, 488
  - zinc,
    - ethyl, 1, 518–522
    - methyl, 1, 518–522
- Litmus, 1, 221**
- absorption spectrum, 1, 222
- Loaded structures, 8, 361**
- Loading and fibre torsion, 4, 371**
- hysteresis, 4, 139
- Loadstone in magnetic field, 8, 490–509**
- planes of force, 8, 503–506
- Lobster, colour, 10, 236**
- Local field, 6, 163–164**
- Locomotive, 3, 451**
- Loess, 10, 158**
- Logwood,**
- charcoal, 6, 395
  - synthesis, 9, 24
- Lloyd's bands, 5, 480**
- London water supply, 2, 264**
- Long-distance photography, 10, 137**
- Lophin, 9, 219**
- Lorenz–Lorentz field, 6, 163–164**
- Lorenz's method of resistance measurement, 4, 430**
- Loss,**
- energy in discharge, of, 4, 175
  - hysteresis, 4, 136, 512–515; 8, 509
  - and low temperature, 4, 545–547
  - magnetism by heat, of, 1, 3
  - reflection, 8, 275–283
- Lothar Meyer's curve, 8, 325**
- Loudspeaker, 9, 282**
- Low F, 8, 205–207**
- Low-pressure,**
- combustion, 1, 360–364
  - discharges, 9, 122–130

**Low-pressure—*cont.***

- measurement, 6, 260–261
  - spectra, 8, 242
- Low-temperature, 8, 66–99, 253–290**
- absorption of X-rays, 5, 468
  - adsorption, 6, 104–119, 213–215
  - charcoal, on, 6, 397–404
  - isotherm, 6, 214–216
  - analysis, 5, 468
  - bacteria at, 6, 437; 7, 84
  - effect on, 5, 470–471; 6, 437; 7, 84
  - phosphorescence, 7, 83–92
  - biological effects, 4, 222
  - breaking stress, 4, 267–270
  - calorimetry, 7, 391–401
  - carbonisation, 9, 326
  - chemistry, 7, 135–153
  - conductivity, 4, 229–231; 9, 419–445
  - demonstration, 6, 38
  - density measurement, 6, 1–9
  - dielectric constant, 6, 419
  - electrical properties, 4, 517–548
  - electrification, 6, 210–211
  - expansion coefficient, 6, 1–9
  - experiments, 3, 23
  - helium at, 6, 248–261
  - history of, 5, 454–455
  - hysteresis, 4, 545–547
  - life at, 6, 437
  - magnetic properties, 4, 270–272, 517–548
  - magnetisation, 4, 541–548
  - measurement, 3, 22–23; 4, 219; 10, 84–86
  - metal flow, 6, 7
  - papers, 5, 472–475
  - phosphorescence, 4, 375–381; 5, 464; 7, 81
  - photochemistry, 7, 80–92
  - photography, 4, 222, 378–380; 5, 167–169, 465; 6, 424
  - properties, 5, 459–465; 6, 1–9
  - research at R.I., 6, 391–450
  - resistance, 4, 229–231; 9, 419–445
  - coil, 4, 518–519
  - rigidity, 4, 266–270
  - screening, 4, 530–531
  - specific heat, 8, 104–106
  - steel, effect on, 6, 425–426



**Low temperature—*cont.***

- thermal insulation, 5, 465
- thermoelectric effect, 4, 219, 505–541
- thermometry, 5, 458; 6, 433–435; 7, 223–228
- viscosity, 6, 387–388
- vitality, 6, 437; 7, 80
- Voltaic cells, 5, 465
- X-rays, absorption of, 5, 468
- Young's modulus, 4, 266–270
- Lowest temperature,**
  - 1891, 4, 160
  - 1899, 5, 213
- Lubricating,**
  - films, 9, 109
  - oil from coal, 9, 340
- Lubrication and structure,** 9, 45
  - boundary, 9, 46
  - theory, 7, 440
- Lucifer matches,** 1, 159
- Luciferase,** 9, 222
- Luciferin,** 9, 222
- Luminescence,** 4, 502
  - decaying organic matter, of, 4, 375
  - definition, 4, 506–507
  - phosphorous, of, 1, 22
  - types of, 4, 507
- Luminescent marine animals,** 4, 375
- Luminosity,**
  - active nitrogen, of, 7, 306
  - duration in explosion, 6, 301
  - flames, of, 1, 363; 6, 300
  - night sky, of, 9, 270–271
  - striations, of, 7, 44–45
- Luminous,**
  - flames, 2, 151–155; 5, 27–35
  - paint, 3, 252
- Lummer and Pringsheim's results,** 8, 276
- Lummer–Gehrcke plate,** 8, 239
- Lung tissue,** 6, 120
- Lupus,** 6, 49
- Lutein,** 10, 228–234
  - chromatography, 10, 231
  - in food, 10, 235
- Luteolin,**
  - chloride, 9, 118
  - formula, 9, 116–117
  - fusion with alkalis, 9, 116

- Lutidine,**
  - from coal, 1, 400
  - infrared transmission, 8, 288
- Luxmasse,** 9, 331
- Lycopene,** 10, 231–234
  - biogenesis, 10, 237
  - chromatography, 10, 231
  - spectrum, 10, 232
  - structure, 10, 232
- Lycophyll,** 10, 234
- Lycopodium,** 4, 494
  - insulation, 5, 164
  - powder, 2, 57; 9, 298
  - anomalous movement, 9, 291–292
- Lycoxanthin,** 10, 234
- Lyddite,** 7, 195
- Lyman series of hydrogen,** 8, 34–46
  - prediction, 8, 108
- Lymphs,** 9, 295
- Lyoluminescence,** 4, 507–508
- Lyra,**
  - hydrogen in, 2, 48
  - ring nebula, 8, 40

**M**

- M.K.S. units,** 3, 92
- Macaroni,** 2, 276
- Machine,**
  - calculating tides for, 6, 372
  - electrical, 3, 466–471
  - freezing, 4, 475
  - Holtz, 4, 171
  - Whimshurst, 3, 466–471
  - Whitworth, 4, 444; 5, 556
- Mackerel, photobacteria in,** 7, 84
- Macromolecules,** 10, 257–269
- McLeod gauge,** 6, 260–261
- Madder,** 2, 240–245
  - root, 2, 191
  - world production, 2, 241
- Magdala,** 2, 190–192
- Magdeburg hemispheres,** 9, 233
- Magenta,** 1, 397–412, 569–570; 2, 184
  - B, 3, 368
  - from 1 ton coal, 3, 365–366
  - R, 3, 368
- Magne-crystals,** 1, 193–195, 296; 2, 88–96; 9, 131–154
- Magnesia,** 1, 284–289; 7, 29

**Magnesia—*cont.***

catalysis of combustion, 7, 406

glass, in, 9, 157, 161

insulation, 5, 164

melting-point, 7, 237

**Magnesite, 8, 299–301****Magnesium, 1, 284–289**

abundance, 10, 272

alkyl halides, 7, 203

aluminium alloy, 10, 251

arc spectrum, 3, 206

arcs in different gases, 3, 186–199

atomic,

heat, 7, 401

radius, 8, 326; 9, 502

refraction, 2, 541

spectrum, 1, 433; 3, 69–78, 186

203, 206

volume, 7, 401

weight, 1, 500–508, 535; 2, 325,

541; 8, 129

non-integral, 8, 129

bacteria, action on, 7, 86–92

photographic plate, 5, 257

burnt by infrared, 1, 533

cadmium arc, 7, 82

caesium selenate, 5, 544

calcium silicate, 1, 331

carbonate,

artificial photosynthesis, in, 9, 195

Bath springs, in, 5, 158

crystal structure, 8, 329

chloride,

Bath springs, in, 5, 158

density, 1, 6

depression of freezing point, 6,

97–98

electrolysis of fused, 1, 286

expansion, 6, 6

media, in, 7, 84

discovery, 2, 315–317

double sulphates, 5, 539

earth's crust, in, 7, 54

electrodes, 1, 186–199; 3, 107–108;

7, 403

electron diffraction, 9, 191

flame,

spectrum, 3, 186–199, 206

ultraviolet, 3, 260–261

flash-light, 4, 58

formation of X-rays, 4, 504

**Magnesium—*cont.***hydrogen absorption spectrum, 3,  
70–71, 206

hydrogen carbonate, basic, 1, 332

hydrogen compound, 3, 188–189

ionic radius, 9, 80, 86

lead thermocouple, 4, 538

nitrate, 2, 209

nitrogen removal, 4, 403

nuclear fission, 9, 15–16

occurrence, 9, 245

oxide, 8, 321, 329

permanganate, 6, 100

photography, use in, 1, 514–515

platinocyanide, 1, 487

platinum couple, 2, 497–498

potassium,

absorption spectrum, 3, 70, 189

selenate, 5, 544

sulphate, 3, 398

production, 1, 285–287

properties, 1, 286–287

resistance and temperature, 4, 524–  
527

rigidity, 8, 360

rubidium selenate, 5, 544

silicate, 1, 331

crystal structure, 7, 130–133

silicide, 1, 331

sodium spectrum, 3, 70, 189; 8, 373

specific heat, 2, 325; 7, 233–234

spectrum, 1, 433; 3, 69–78, 186–203,  
206, 255–265

burning, of, 1, 514–515

diagrams, 3, 266

spark of, 3, 206

sulphate,

seeding, 3, 398

solution conductivity, 6, 94

supersaturation, 3, 398

ultraviolet absorption, 1, 436–431

water eutectic, 2, 522

water phase diagram, 2, 523

sun, in, 1, 358, 433

trace in explosion, 3, 445–450

ultraviolet spectrum, 3, 258–265

Young's modulus, 8, 354–355

Zeeman effect, 5, 274

**Magnetic,**

balance, 1, 2, 64–73; 2, 96–101

**Magnetic—cont.**

birefringence (*see Magneto-optical effect*)

compass, 4, 96-97

curve tracer, 4, 513-514

declination, 1, 73

dip, 1, 10, 73

disturbances, 1, 435-441

domains, 10, 460

field, 4, 7-12

atoms, in, 7, 502

cathode rays, effect on, 5, 38-41

cooling of iron in, 4, 141

definition, 4, 127

disc rotating in, 4, 430-444

discharge, effect on, 1, 314-318;

3, 54, 220-226; 4, 290; 5,

38-39

minerals in, 8, 489-509

motion of copper plate, 4, 74-77

rays, 3, 53-54

negative glow, effect on, 1, 315

$\alpha$ -particles in, 8, 522-536

polarisation, and, 4, 21-22

radioactivity, effect on, 5, 513

radium rays in, 6, 43

resistance, and, 3, 216; 4, 534-535

rotation in, 4, 82-86

silver atoms in, 9, 90-91

solid air in, 4, 460

spectra, effect on, 5, 264-276

superconductivity in, 9, 425-429

varying, 4, 99

fluid, 1, 140

force, 1, 9, 25-28, 59-73, 188-195,  
227-240

direction of, 1, 28

hysteresis (*see Hysteresis*)

inclination, 1, 10; 4, 7

induction, 4, 127-141

definition, 4, 8, 127

hysteresis, and, 8, 508-509

maximum, 4, 9

inductive capacity, 4, 140

inertia, 3, 287-288

leakage, 4, 87

lever recorder, 5, 422-423

lines of force, 4, 7-12; 9, 139

moment, 9, 88

needle, 1, 25-26

oscillator, 4, 18-19

**Magnetic—cont.**

oxide, 1, 161, 528; 9, 489-509

in glass, 9, 160-163

permeability, 4, 430-431

and screening, 4, 96

temperature, 9, 443-445

phenomena, 4, 7-12

poles, conical, 1, 2-3

properties and crystal structure, 9,  
462

at low temperature, 4, 517-548

gases, of, 8, 433-434

liquid oxygen, of, 4, 218-222;  
5, 4-10

pyrites, 8, 495-509

saturation, 4, 128-130

screening, 5, 13

demonstration, 4, 101-103

self-induction, 1, 87

slate, 1, 191

storms, 1, 435-441

susceptibility, 9, 89; 10, 85-98

crude measurement, 3, 284-285

crystals, of, 10, 142-147

gases, of, 9, 91-92

liquid oxygen, of, 5, 4-10

liquids, measurement, of, 5, 4-10

variation, 1, 9-12, 72-73

Magnetisation, 4, 139; 6, 98; 10,  
99-107

currents, effects of, 4, 412-425

cyclic, 4, 135, 423-425

demonstration, 4, 130-136

earth's magnetic field, by, 3, 18-20

infrared, of, 2, 331-334

iron, of, 4, 412-425

light, of, 2, 331-334

mechanism, 4, 129-130

model, 4, 130-136

stress, and, 3, 18-20; 4, 130

temperature, and, 4, 140

at low, 4, 541-548

tension, and, 3, 18-20; 4, 137-140

vibration, effects of, 4, 136-137

Magnetism, 1, 59-63, 188-195,  
523-528

air, of, 1, 9-12, 68

alcohol, of, 1, 68

alloys, of, 10, 485

alternating, 8, 489-509

ammonia, of, 1, 68

**Magnetism—cont.**

- Ampère's theory, 3, 281–282
- arsenic chloride, of, 1, 68
- antimony, of, 1, 191
- atmospheric, 1, 2–3, 9–12; 2, 96–101
- bismuth, of, 1, 68–70, 145, 150–153, 193–195
- camphine, of, 1, 68
- camphor, of, 1, 68
- carbon, of,
  - dioxide, 1, 68
  - disulphide, 1, 68
- cobalt, of, 1, 1
- conduction of, 1, 11
- copper, of, 1, 191
- crystals, of, 1, 296; 10, 142–147
  - structure, and, 1, 193–195
- cuprammine complex, of, 1, 68–69
- cyanogen, of, 1, 68
- earth, of, 1, 3, 9–12, 435–441; 2, 96–101; 4, 425
- electricity production, and, 1, 26–28
- ether, of, 1, 68
- Faraday's work, 2, 54–55; 9, 135–136
- fluid theory, 1, 29
- fused lead borate, of, 1, 68
- gases, of, 4, 220
- glass, of, 1, 67–73, 192
- heat, and, 4, 11–12
  - effect, 1, 29–33, 197
  - loss, of, 1, 3, 9–12
- hydrogen, of, 1, 68
- Iceland spar, of, 1, 80, 192, 193–195
- iron, of, 1, 191
  - carbonate, 1, 191
  - chloride, 1, 191
  - elongation of, 1, 523–528
  - sulphate, 1, 191
- light transmission, effect on, 1, 30
- linseed oil, of, 1, 68
- liquid air, of, 4, 221
- marble, of, 1, 192
- molecules, of, 3, 281–290; 4, 151–156
- nickel, of, 1, 1
  - sulphate, of, 1, 79
- nitric acid, of, 1, 68
- nitrogen, of, 1, 68
- oil of lemons, of, 1, 68
- olefiant gas, of, 1, 68
- olive oil, of, 1, 68

**Magnetism—cont.**

- oxygen, of, 1, 1–3, 9–12, 68–69; 2, 96–101
    - attempted condensation of, 1, 3
  - permanent, 1, 69–73
  - phosphorous, of, 1, 145, 192
  - potassium,
    - ferrocyanide, of, 1, 191, 194
    - nitrate, of, 1, 192
  - quantum theory, 9, 88–92
  - residual, 4, 127, 129
  - separation, of,
    - iron filings and sand by, 1, 2
    - oxygen and nitrogen by, 1, 2–3
  - shale, of, 1, 79
  - soap bubbles, of, 1, 2; 2, 96–101
  - soft iron, of, 1, 1
  - sound, and, 1, 523–528
  - space, of, 1, 63
  - stress, and, 3, 282
  - sulphur, of, 1, 68, 192
  - sulphuric acid, of, 1, 68
  - sun's spots, and, 1, 435–441
  - temperature and, 1, 195; 5, 461–462
    - at low, 4, 270–272
  - thallium, of, 1, 444
  - time, and, 1, 71
  - tourmaline, of, 1, 80, 193–195
  - water, of, 1, 66–69
  - zinc, of, 1, 68
- Magnetite,**
- crystal structure, 8, 330
  - hardness, 8, 330
  - hysteresis coefficient, 8, 508
  - magnetic field, in, 8, 489–509
  - planes of force, 8, 504–506
  - X-ray diffraction, 7, 353
- Magneto,**
- cathodic rays, 6, 322
  - electric action, 3, 216–226
    - induction 2, 58–67; 3, 300–311
  - optical effect, 1, 81–82; 2, 84–88; 3, 516–539; 5, 170–188, 266; 6, 98, 120–124, 190–209; 9, 104, 132; 10, 165
  - discovery by Faraday, 2, 54–67, 84–88
  - Faraday's work, 4, 155
  - gyroscope, and, 6, 371
  - theory, 5, 177–188

**Magneto—cont.**

- optical properties of,
  - nickel carbonyl, 4, 211
  - thin films, 5, 175
- thermodynamics, 6, 361–363
- Magnetomotive force, 4, 87
- Magneton, Bohr, 9, 91
- Magnetostatic screening, 4, 96–97
- Magnetostriction, 10, 460–461
- Magnets,
  - A.C., 8, 489–509
    - ageing, 4, 542
    - bar, 1, 25–28, 59–65
    - breaking of, 4, 128
    - cooling, effect of, 4, 270–272
  - D.C., 8, 489–490
  - multiphase, 8, 495–509
  - multipole, 8, 495–501
  - permanent, 10, 458–462
  - reflection of light from, 3, 533–534; 5, 176–177
  - ships, 6, 372
  - X-ray analysis, 10, 461
- Magnifying power, 6, 128–130
- Magnus' green salt, 2, 249
- Mahogany, 5, 259
- Mains frequency, 7, 266
- Malic acid, 1, 454, 542
  - optical activity, 1, 7–8
- Malleability, 8, 361–362
  - and crystal structure, 9, 2
  - of copper, 9, 2
- Mallow, wild, 9, 115
- Malachite green, 3, 368
- Malonates, 8, 344–345
- Malonic,
  - acid azides, 7, 201–202
  - ester diazide, 7, 201–202
- Maltose, 9, 50
  - structural formula, 9, 57
- Man carotenoids in, 10, 235
- Manchester yellow, 3, 368
- Manganates, 2, 182
- Manganese,
  - abundance, 10, 272
  - aluminium silicate, 1, 331
  - ammonium sulphate, 10, 92
  - atomic,
    - heat, 7, 401
    - radius, 8, 326
    - refraction, 2, 541

**Manganese—cont.**

- atomic—cont.
    - volume, 7, 401
    - weight, 1, 500–508; 2, 325
  - chloride, 2, 209
  - columbite, in, 7, 48
  - dioxide, 1, 161, 282
    - chlorine production, use in, 2, 265–270
    - industrial use, 3, 500–501
    - regeneration, 2, 268–269
  - discovery, 2, 316–317
  - fluorine, action of, 5, 96
  - glass, in, 9, 164
  - Heusler's alloy, in, 8, 489
  - iron alloy, 4, 525–529
  - iron silicate, 1, 331
  - magnetic susceptibility, 3, 285
  - nature, in, 4, 240
  - recovery process, 3, 500–501
  - specific heat, 2, 325
  - steel, 4, 214
    - ductibility, 6, 425
    - lead thermocouple, 4, 538
    - resistance, 4, 525–529
    - temperature, effect of, 6, 425
    - tensile strength, 6, 425
  - sulphate-calcium sulphate solid solution, 5, 37
  - sulphate hydrate, 2, 209
  - sun, in, 1, 433
  - tantalite, in, 7, 48
  - trace in explosion, 3, 446–450
  - ultraviolet spectrum, 3, 258
- Manganic,**
- acid, 1, 333
  - compounds, 2, 181
  - salts, colour, 2, 182
- Manganin-lead thermocouple, 4, 538**
- resistance, 4, 525–529
- Manganous,**
- chloride, 2, 268–269
  - compounds, 2, 181
  - ion, radius, 9, 86
  - salts, colour, 2, 182
  - sulphate, electrolysis, 5, 498
- Mannosans, 9, 50**
- Mannose, 9, 50**
- structure, 6, 38
- Manometer, Petavel, 8, 463–465**

- Mantle,**  
   gas, 6, 388-389; 7, 46  
   Welshbach, 5, 393  
**Marble, diamagnetism, 1, 192**  
**Marcasite, 2, 353**  
**Marcet, Mrs., 2, 52-53**  
**Marconi oscillators, 7, 280-281**  
**Margaric acid, 1, 546-547**  
**Marine organisms, chemiluminescence,**  
   4, 375, 507  
**Marine snail, 9, 103**  
**Mars,**  
   orbit, 8, 191, 226  
   temperature, 9, 227  
**Masonry, 3, 351**  
**Mass,**  
   action, 7, 248  
   aether, and, 6, 291  
   atom, of, 5, 404  
   charge ratio, of, 7, 184-194  
     electrons, 5, 48-49, 405  
     hydrogen ion, 5, 49  
     ions, 6, 233-247  
     kanalstrahlen, 6, 232  
      $\alpha$ -particle, 6, 284; 7, 503  
     positive rays, 6, 314-344  
   conservation of, 1, 236; 5, 311  
   defect, 8, 129, 341; 10, 28  
   distortion of space, 8, 190  
   earth, of, 4, 352  
   electromagnetic origin, 8, 119, 129  
   electron, of, 5, 407; 9, 205  
   hydrogen atom, of, 7, 179  
   light, 8, 192  
     deflection, of, 8, 214-215  
   neutron, of, 9, 416; 10, 109  
   positive ions, of, 5, 408  
   quasi-, 8, 217-221  
   relation to length and time, 4, 429  
   spectrometer, 7, 184-194, 294-305;  
     8, 332-342  
   spectrum analysis, 7, 184-194  
   sun, of, 5, 297  
   universe, of, 6, 289  
**Masses, astronomical, 4, 350-351**  
**Mastic, 7, 174-183**  
   light scattering, 4, 280  
**Matches,**  
   lucifer, 1, 159  
   manufacture, 1, 38  
**Material granular, 3, 350-359**  
**Materials, strength of, 8, 361**  
**Mathematical transformation, 8, 187**  
**Matter,**  
   aether, and the, 2, 528-539; 8, 212-  
     235  
   conservation of, 1, 236; 5, 311  
   electricity, and, 8, 115-119  
     anisotropic, of, 8, 349  
   fourth state of, 1, 281; 5, 551  
   radiant, 4, 490-492; 5, 557  
   states of, 2, 294-301; 4, 104-113  
   theory of, 1, 78-83  
   ultra-atomic, 5, 556-558  
**Mauve, 2, 184**  
   discovery, 2, 240; 3, 369  
   dye, 1, 397-412  
**Mauveine, 2, 185**  
   discovery, 9, 21  
   reduction, 2, 185  
   structure, 2, 187  
**Maximum,**  
   conductivity, 5, 491  
   current in superconductor, 9, 426  
   density of water, 4, 4  
   flame velocity, 4, 143  
**Maxwell,**  
   equations, 8, 516-517; 9, 549  
   sorting demon, 3, 36-37  
   theory of electricity, 8, 213  
     7, 497-498  
   velocity distribution, 5, 353-358;  
**Mean,**  
   density of earth, 4, 373  
   free path, 3, 38-59, 136; 7, 169-171  
   lines, 1, 298-304  
**Measurement,**  
   absolute resistance, 4, 426-446  
   atomic mass, 7, 164-183  
   Avogadro's number, 7, 164-183  
   bulk modulus, 8, 348-349  
   colloid rigidity, 9, 176  
   contact electricity, 5, 58-61; 80-83  
   density, 6, 1-9  
   distance, 4, 361-364  
   electronic charge, 7, 182  
   film thickness, 9, 40  
   G, 5, 296-303; 10, 101-103  
   gas,  
     density, 4, 397  
     viscosity, 5, 249-252  
   goniometric, 7, 325

**Measurement—cont.**

- heat transmission, 8, 257–270
  - high pressure, 8, 463–465
  - high temperature, 3, 87–90; 5, 236–252; 7, 238
  - infrared reflection, 9, 223
  - length, 5, 556
    - and optics, 3, 229
  - low pressure, 6, 260–261
  - low temperature, 10, 84–86
  - magnetic susceptibility,
    - gases, of, 9, 91–92
    - liquids, of, 5, 4–10
  - particle size, 7, 174–176
  - Poisson's ratio, 8, 352
  - pressure difference, 7, 12
  - protein molecular weights, 10, 217
  - radiation, 8, 253–270
    - pressure, 8, 514
  - $\gamma$ -ray frequency, 9, 12–13
  - refractive index, 4, 449–453; 5, 18–20
  - resistance, 4, 519–521
  - rigidity, 8, 355–359
  - small forces, 3, 560–569
  - solution vapour pressure, 7, 12
  - sound,
    - intensity, 8, 363–369; 9, 289
    - velocity, 9, 305
  - star diameters, 8, 519
  - sun's intensity, 1, 456–462
  - temperature, 2, 342–352; 5, 450–451
  - ultraviolet radiation, 1, 319
  - viscosity, 4, 454–455; 5, 136–140; 6, 67–73; 9, 169
  - X-ray wavelength, 7, 449–454
- Measuring machine, Whitworth, 4, 444**
- Mechanical,**
- action of light, 2, 442–465
  - analogy of charging circuit, 3, 482
  - equivalent of heat, 1, 183, 196–201; 2, 77, 420; 4, 1–6, 275
  - properties and crystal structure, 9, 462
  - radiation detectors, 4, 341
  - response of muscle, 5, 417–418
  - stimuli, 5, 418
  - strength of hydrogenated palladium, 2, 239
  - vibrations, 8, 198–211
  - work by animals, 1, 377–378
- Mechanics, wave, 9, 183, 202–204**

**Mechanism,**

- carbon monoxide combustion, of, 8, 471–473
  - combustion of, 4, 147–149; 6, 301–313
  - electrolysis, of, 5, 484–499
  - Grotthus, 6, 92–93
  - hydrogenation, of, 10, 65
  - magnetisation, of, 4, 129–130
  - polymerisation, of, 10, 261–269
  - reaction, 10, 384–403
  - saponification, of, 10, 68–69
- Mecocyanin, 9, 120**
- Medical effects of,**
- antipyrene, 3, 371
  - kairine, 3, 370
  - pyridine salts, 3, 370
  - quinine, 3, 369–370
- Medical use of,**
- osmium, 7, 47
  - saccharine, 3, 375–376
- Medicines from coal-tar, 3, 369–372**
- Medium,**
- gyrostatic, 5, 170–188
  - motion of, 4, 190–196
  - photobacteria, for, 7, 84
- Meerschau, adsorption, 6, 105, 214**
- Meker burner, 7, 237**
- Melanin, 4, 235**
- Meldometer, 5, 240**
- Meletot, fragrance, 2, 146–147**
- Meletoto officinalis, 2, 146–147**
- Melissic,**
- acid, 1, 546–547
  - alcohol, 1, 546
- Mellate, ammonium, 1, 299–301**
- Mellitic acid, 6, 414**
- structure, 6, 231
- Melting,**
- point and,
    - critical temperature, 5, 319
    - impurity, 7, 17
    - maximum, 7, 26
    - pressure, 7, 17–19
    - rigidity, 8, 359–360
    - Young's modulus, 8, 355
- points, 1, 134–135**
- metals, of, 5, 241
  - paraffins, of, 7, 133
- steel, 7, 374–377**

**Melting—*cont.***

- sulphur, 1, 134–135
- volume change, 7, 17

**Membranes,**

- osmosis, for, 2, 217
- pots, in, 7, 5
- rubber, 7, 470–486
- semi-permeable, 1, 395; 7, 5–15

**Meniscus at critical point, 4, 109****Menthol, 6, 12****Mercaptan, 8, 284****Mercerised cotton 1, 34–41**

- structure, 9, 259

**Mercuric (*see also Mercury*)**

- bromide, 3, 400
- chloride, 9, 71
  - aniline, reaction with, 1, 408
  - bacteria, action on, 7, 86–92
  - effect in photography, 4, 44
  - formula, 1, 536; 2, 196–197
  - osmosis, 2, 217
  - reduction catalysed by palladium, 2, 233–239
  - supersaturation, 3, 400
  - water eutectic, 2, 522
- cuprous iodide, 7, 121
- fluoride, 5, 96
  - action of chlorine, 5, 89
- iodide,
  - allotropy, 1, 37
  - colour, 6, 416
    - and temperature, 4, 261, 378; 5, 464; 6, 428
  - infrared absorption, 2, 5
  - insulation, 5, 164
  - supersaturation, 3, 400
  - transformation under pressure, 7, 21
- nitrate basic 1, 333
- oxide, 7, 152

**Mercurous (*see also Mercury*)**

- chloride, 7, 100

**Mercury,**

- ammonia, electrolytic action of, 1, 210–211
- amyl,
  - chloride, 1, 518–522
  - iodide, 1, 518–522
- arc, 7, 372–377
  - for Raman spectra, 9, 278

**Mercury—*cont.***

- atomic,
  - heat, 5, 192; 7, 401
  - refraction, 2, 138, 541
  - spectrum, 1, 384; 3, 134; 7, 375–379
  - volume, 7, 401
  - weight, 1, 500–508, 535; 2, 315; 8, 340
- bacteria, action on, 7, 86–92
- boiling point, 7, 237
- breaking stress, 4, 269
- bulk modulus, 8, 348–349
- capillary action, 6, 15–16
- coherence, 8, 347
- compressibility, 8, 294
- conductance, 3, 92
  - liquid helium, in, 7, 234
  - temperature, and, 4, 524–533
- critical point, 6, 21–22
- cyanide, action on bacteria, 7, 86–92
- density, 2, 154; 6, 5–6; 8, 339
- diamyl, 1, 518–522
- diethyl, 1, 518–522
  - formula, 1, 536
- diffusion pump, 4, 226–227; 7, 388; 9, 241–244
- dimethyl, 1, 518–522
- distillation, 4, 227
- electrical discharge, 2, 154; 4, 287
- emissivity, 8, 290
- ethyl, 1, 518–522
  - chloride, 1, 518–522
  - iodide, 1, 518–522
- expansion, 6, 5–6
- fluorine, action of, 5, 96
- fractional distillation, 8, 339
- freezing, 7, 225
- friction, 4, 3
- fulminate, 8, 297
- glass thermometer, in, 7, 238
- gravitational effects, 5, 305
- heated under pressure, 6, 21–22
- ion, 7, 186–187
- iron, amalgamation, of, 8, 294
- isotopes, 8, 339–340
- lithium,
  - ethyl, 1, 519–522
  - methyl, 1, 518–522
- mass spectrum, 7, 188; 8, 339–340
- melting point, 7, 237



**Mercury—cont.**

- methyl iodide, 1, 518–522
- motion, 8, 185
- nitrogen compound, 7, 311
  - active, and, 7, 311
- orbit, 8, 102, 190–191, 226
- organic compounds, 1, 518–522
- oxide,
  - colour, 4, 261, 378
  - formula, 2, 196
  - reaction with carbon monosulphide, 7, 152
- pressure column, 5, 452
- process for estimating nitrogen, 3, 87
- radiometer, 6, 260–261
- ratio of heat capacities, 5, 335; 8, 104
- reflection by, 4, 480
- sensitisation, 9, 220
- separation of isotopes, 8, 339
- silica thermometer, in, 7, 238
- specific heat, 2, 325; 5, 192
- spectrum, 1, 384; 3, 134; 7, 375–379
- splashes, 4, 291–320
- sulphide,
  - allotropy, 1, 37
  - colour and temperature, 4, 261
- sulphosalicyclic acid,
  - birefringence, 9, 177
  - formula, 9, 179
  - rigidity, 9, 177
- sulphur, reaction with, 6, 219–225
- superconductivity, 9, 421
- surface effects, 3, 341
  - tension, 4, 118
- vacuum flask, use in, 4, 229
- vapour,
  - conductivity, 6, 21–23
  - discharge in, 2, 154; 4, 287
  - Faraday, study by, 2, 55–56
  - fluorescence, 7, 206, 217–220
  - lamp, 7, 83, 372–377
  - pressure, 4, 227; 6, 219–225
  - viscosity, 7, 388
  - velocity, 8, 190–191
  - volatility, 2, 400
  - vortex, 10, 180
  - Zeeman effect, 6, 204–205, 208
- Meridian, motion 1, 13–17
- Mesothorium,
  - I and radium, 8, 120–121
  - half-life, 8, 453, 457

**Mesothorium—cont.**

- II, half-life, 8, 453, 457
- from monazite 8, 122
- Meta-elements, 8, 450–451
- Metabolism, 9, 49
- Metal,
  - carbonyls, 4, 208–217
  - compounds, 5, 195–196
  - conductors, 6, 376
  - crystals, 8, 330; 9, 2
  - Dewar vessels, 6, 218, 404–405; 7, 64–66, 390
  - dust in electric discharges, 4, 284
  - fatigue, 10, 225–226
  - filing coherer, 4, 336
  - films,
    - electron diffraction, 9, 190–192, 208–210, 360
    - magneto-optical effects, 5, 175
    - thin, 3, 239
    - X-ray diffraction, 9, 2
  - flow, 6, 7
  - organic compounds, 1, 518–522
  - oxide,
    - cathode, 6, 167
    - sols, 10, 148
  - salts,
    - electrolysis, 2, 340–341
    - in dyeing, 9, 23
  - vacuum syphon, 7, 64–66
  - wires, gas reactions on, 6, 300
  - working, 9, 2
- Metallic,
  - azides, 7, 197–198
  - beetles, 9, 261–262
  - colours, 9, 18
- Metallurgy, 9, 2
- Metals,
  - alkali, discovery of, 6, 262–274
  - alkaline-earth, 1, 284–289
  - allotropy, 5, 192
  - alloys, in, 5, 195
  - atomic weights, 1, 500–508
  - attractive force between, 5, 68–71
  - bulk modulus, 8, 347
  - catalysis of gas phase reactions, 2, 72; 6, 300
  - colour tests for, 1, 354–355
  - combustion catalysts, as, 7, 405–408
  - conductivity, theory of, 5, 411–412
  - contact electricity, 5, 50–83

**Metals—cont.**

- crystallisation, 2, 335–341
- discovery in spectra, 1, 509–515
- diffusion in, 10, 248–250
  - through at high temperatures, 7, 465–469
- earth's centre, in, 7, 55
- electrical response, 5, 27–38
- electrodeposition, 2, 341
- electron density, 5, 412
- electrons in, 5, 411–414
- electropositivity, 5, 562
- etching of, 4, 123
- heat conduction, 5, 412–413; 6, 213
- melting points, 7, 237
- microscopic study, 5, 447–448
- occlusion of gases by, 2, 48–49, 233–239
- phosphorescence, 4, 377
- photographic plates, action on, 5, 257–263
- platiniferous, 1, 352–353
- polarisation, 9, 444
- polished, 10, 248
- polishing temperature, 10, 250
- production by displacement, 1, 285
- reflection of ultraviolet, 1, 431
- resistance at low temperatures, 4, 229–231
- resistivity and temperature, 4, 518–543
- spectra, 1, 384, 431–434, 510–512
- sun, in, 1, 510–512
- superconductivity, 9, 419–445
- temperatures, effect of low, 6, 425–426
- traces in explosions, 3, 442–450
- transmutation, 9, 263–264
- vaporisation, 2, 56
- X-ray,
  - diffraction, 9, 2
  - opacity, 4, 486
- Metamers, 2, 194
- Metanil yellow, 3, 368
- Metaphosphates, 1, 332; 2, 502
  - Graham's work, 2, 207–208
- Metaphosphoric acid, 1, 333; 2, 208–209
- Metasilicates, 1, 332
- Metasilicic acid, 1, 333
- Metavanadates, 2, 502
- Metavanadic acid, 2, 502–503
- Metaxylene from coal, 3, 365–366
  - viscosity, 5, 142–154
- Meter, electric, 4, 88–89
- Meteorites, 1, 417
  - life on, 4, 222
- Meteorology, 4, 175
  - effect of sun on, 1, 425–426
- Methaemoglobin, 10, 432
- Methane, 1, 273, 331
  - adsorption on charcoal, 6, 119
  - air explosion, 8, 69–70
  - Bath gas, in, 5, 158
  - calcium acetate, from, 3, 363
  - coal, from, 1, 399
  - coal-gas, condensation from, 5, 322
  - combustion, 6, 303–313
  - critical constants, 3, 315
  - derivatives, 3, 551
  - effusion rate, 2, 40–44
  - electrical discharge in, 2, 356
  - ethane from, 9, 350–351
    - explosion, 6, 313
  - Faraday, study by, 9, 95
  - flame,
    - photography, 9, 476–477
    - velocity, 9, 468
    - vibrations, 4, 144
  - formation, isotope effect, 10, 49
  - formula, 1, 154–155, 446–448, 455, 544–545; 2, 194
  - graphite, diffusion through, 2, 41–44
  - ion, 7, 187
  - liquid, density of, 6, 249
  - mass spectrum, 7, 187–192; 8, 336–337
  - molecular structure, 1, 556, 560–562, 564
  - occurrence, 1, 544–545; 2, 479–480, 486
  - oxygen,
    - explosion, 3, 446–447
    - flame, 4, 145–149
  - preparation, 2, 498
  - rubber, diffusion through, 2, 38–44, 229–233
  - sound from radiation, 3, 156–157
  - synthesis, 1, 477–478
  - thermal decomposition, 9, 349–351
  - triethoxy, 2, 386
  - ultraviolet absorption, 1, 430–431

**Methane—*cont.***

viscosity, 2, 219–221

Method of mixtures, 6, 74

**Methyl,**

acetate,

infrared transmission, 8, 287

viscosity, 5, 142–154

acrylate, polymerisation, 10, 401–402

alcohol, 1, 479; 2, 195, 198, 387

crystals, 4, 263

formula, 1, 545–546; 2, 486

infrared transmission, 8, 286

molecular structure, 1, 564

silicon analogue, 2, 387

sugar beet, from, 3, 31

synthetic production, 9, 352–356

viscosity, 2, 212–213; 5, 142–154

water mixtures, viscosity, 2, 212–213

aluminium, 1, 535–538

dimerisation, 1, 539

anthranilate, 6, 12

benzthiazole, 10, 133

bromide, 2, 145

butyrate,

formula, 1, 547–548

viscosity, 5, 142–154

carbylamine, 7, 203 ✓

chloride,

boiling point, 6, 75, 429

critical temperature, 6, 75, 429

discovery, 3, 31

dye synthesis, use in, 3, 34–35

evaporation temperature, 6, 75, 429

formula, 1, 447–448; 2, 194–195

industrial production, 3, 31

liquefaction, 3, 33

methyl sodium, reaction with, 2, 196

molecular structure, 1, 560–564

refrigeration, use in, 3, 31, 33–34

sodamide, reaction with, 2, 196

sodium hydroxide, reaction with, 2, 196

solubility, 3, 32–33

sound from radiation, 3, 157

synthesis, 1, 271

uses, 3, 31

vapour pressure, 3, 33

**Methyl—*cont.***

cyanide,

diffusion through rubber, 7, 471

from sugar beet, 3, 31

hydrolysis, 1, 479

infrared transmission, 8, 288

ether, 1, 55

ethyl,

ether, 1, 155, 451

ketone, infrared transmission, 8, 286

viscosity, 5, 142–154

phenylamine, 1, 449–451

sulphate, 1, 329

formate,

formula, 1, 547–548

viscosity 5, 142–154

groups, rotation in crystals, 9, 505–506

heptenone, 6, 12

iodide,

infrared,

absorption, 1, 497; 8, 285

spectrum, 3, 212–214

reaction with rosaniline, 2, 189–190

saturation current, 6, 18

sound from radiation, 3, 152

viscosity, 6, 141–154

ion, 7, 187

isatin, 7, 365

isobutyl ether, 5, 143–154

isobutyrate, 5, 142–154

lactic acid, 1, 575

lithio-mercury, 1, 518–522

lithio-zinc, 1, 518–522

malonate, 8, 287

mercury, 1, 518–522

iodide, 1, 518–522

nonyl ketone, 6, 12

oxalate,

density, 6, 6

expansion, 6, 5–6

infrared transmission, 8, 287

propionate, 5, 142–154

propyl,

ether, 5, 143–154

ketone, 5, 142–154

pseudoisatin, 7, 365

radical, 2, 176; 4, 207

(ethane) synthesis, 1, 271

**Methyl—cont.**

- rosaniline, 2, 188; 3, 34–35
  - salicylate, 1, 274; 6, 12
  - sodium, reaction with methyl chloride, 2, 196
    - use in synthesis, 2, 146
  - sulphide,
    - from sugar beet, 3, 31
    - viscosity, 5, 141–154
  - tetrazole, 7, 203
  - violet, 3, 34–35
    - 6B, 3, 368
    - R, 3, 368
  - zinc, 1, 139
    - synthetic use, 1, 518–322
- Methylamine**, 2, 186, 195–198; 3, 29–30
  - molecular structure, 1, 564
  - occurrence, 2, 195
  - synthesis, 1, 480; 2, 145, 195
- Methylated glucose**, 9, 53–55
  - properties, 9, 55
  - taste, 9, 55
- Methylation of sugars**, 9, 53–55
- Methylene**,
  - blue, 3, 368
  - chloride, 1, 447–448
    - infrared transmission, 8, 285
    - viscosity, 5, 141–154
  - dichloride, 1, 563–564
  - iodide, 6, 416
    - infrared transmission, 8, 280–281, 285
  - ion, 7, 187
  - radical, 4, 207
- Methyleneimine**, 7, 204
- Metre**, definition, 4, 428–429
- Metric system**, 3, 228–229
- Mhoic effective thickness**, 4, 99–100
- Mica**, 4, 362
  - cleavage, 4, 114
  - effect on  $\alpha$ -particles, 9, 524–529
  - infrared transmission, 8, 273, 284, 289–290
  - liner, 8, 299–301
  - optically-active arrangement, 3, 532
  - quarter-wave plate, 2, 357
  - structure, 10, 271–272, 288–291
  - ultraviolet absorption, 1, 430–431
  - X-ray diffraction, 7, 348, 353
- Micellar theory**, 9, 64–72

**Micelles**,

- crystalline, 9, 67
  - ionic, 9, 64–72
  - neutral, 9, 64–72
  - soap, 9, 67–68
  - starch, 9, 67
  - water content, 9, 68
- Michelson**,
  - interferometer, 4, 387
  - Morley experiment, 8, 101, 181–197, 213
  - velocity of light, 4, 202
- Microbes** (*see Bacteria*)
- Microline**, 5, 22
- Microdissection**, 9, 109
- Micrometer**,
  - discharger, 3, 98–99
  - screwhead, 4, 362
- Microphone**, 4, 323, 5, 501; 10, 172
  - clock, 4, 100
- Microphonic radiation detectors**, 4, 335–336
- Microscope**, 4, 362
  - compound, achromatic, 1, 122–126
  - eye, and, 6, 125
  - glass for, 5, 445
  - glass polishing, use in, 5, 395
  - lenses, testing, 5, 452
  - objective, 4, 184, 6, 125
  - polarising, 7, 325
  - projection, 4, 183–188
    - resolution of, 4, 184
  - scale, 4, 362
- Microscopic study of**,
  - collodion films, 8, 4–6
  - metals, 5, 447–448
- Microscopy**,
  - crystal, 4, 50–51
  - high-power, 6, 120–134
  - staining, 6, 120
- Microultracentrifuge**, 9, 293
- Microwave**, 5, 14–26
  - absorption, 5, 17–18
  - birefringence, 5, 20–23
  - dichroism, 5, 23–24
  - polarisation, 5, 20–25
  - reflection, 5, 18
  - refraction, 5, 18
  - scattering, 5, 18
  - total internal reflection, 5, 18
- Migration of ions**, independent, 5, 493

- Milk,**  
 butter-fat in, 5, 452  
 carotene in, 10, 239  
 phosphorescence, 4, 377; 5, 464  
 refractive index, 6, 166  
 vitamins in, 8, 376  
   A in, 10, 239
- Miller indices, 1, 294-304**
- Millikan, measurement of electronic charge, 7, 182**
- Military,**  
 academies, 2, 276  
 organisation, 2, 276
- Mimetesite, 2, 127; 2, 500**
- Mine,**  
 gravity in, 4, 351  
 pendulum, 4, 354  
 shafts, 8, 292-294
- Mineralisers, 4, 52**
- Mineralogy, use of optics in, 1, 304**
- Minerals,**  
 fluorescence, 4, 491  
 chemistry, 1, 90  
 haloes, 8, 111-112  
 magnetic fields, in, 8, 489-509  
 plasticity, 10, 155  
 separation, 8, 500  
 thixotropy, 10, 150-152  
 water, Nanheim, 1, 509
- Miner's safety lamp, 6, 299**
- Minnie rifle, 1, 118**
- Mirbane, essence of, 3, 372**
- Microfarad, definition, 3, 92**
- Mirror,**  
 beam, 4, 360  
 bending in hydrogen, 4, 370-371  
 mercury vortex, 10, 180  
 metal, 9, 214  
 preparation, 1, 214-215  
 resonator, 4, 390  
 revolving, 3, 218; 9, 122-130  
   determination of light velocity, 2, 437-439  
   examination of arcs by, 3, 108-110  
 telescope, 7, 211-213
- Mistiming, 8, 206**
- Mists, 6, 62-66**
- Mixture,**  
 adsorption of gas, 6, 397-399  
 explosive, 6, 299  
 method of, 6, 74
- Model,**  
 crystal form of, 1, 290-292  
 demonstrating waves, for, 2, 230-231  
 gas, of, 3, 254  
 induction, of, 4, 152-153  
 magnetisation, of, 4, 130-136  
 muscle response, of, 5, 420  
 phosphorescence and fluorescence, of, 3, 250-254  
 polariser, of, 3, 419-522  
 scale, 7, 440-444  
 whispering gallery, of, 9, 288
- Modes, vibrational of string, 2, 23-24**
- Modulus,**  
 elasticity, of, 3, 60-62  
 rigidity (see *Rigidity coefficient*)  
 Young's and melting-point, 8, 355  
 definition, 8, 350  
 temperature, 8, 352-355
- Moiré effect, 9, 130**
- Moist gases, discharges in, 3, 199-200**
- Moisture in air, infrared absorption, 1, 349**
- Molar,**  
 refraction, 2, 136-139, 540  
   and birefringence, 2, 138-139  
 theory, 3, 327-328  
 volumes, 4, 4
- Molasses, 3, 30**
- Mole fraction, 7, 13**
- Molecular,**  
 attraction, 3, 327 (see also *Inter-molecular forces*)  
 change and heat, 1, 4  
 conductivity, 5, 492-493; 6, 93-95, 98  
 contribution, 1, 5  
 crystals, 8, 329-330  
 impacts in discharges, 4, 175  
 magnetism, theory of, 3, 281-290; 4, 515-516  
 motion, 4, 248-249  
   in crystals, 4, 114-115  
 physics, 1, 492-499; 3, 38-59; 8, 100-110  
   and spectroscopy, 3, 122  
 polarisability, 6, 153-166  
 process in magnetic induction, 4, 127-141  
 pump, 7, 390-391; 9, 237-244  
 refraction, 6, 153-166

**Molecular—cont.****refraction—cont.**

double-bond effect, 6, 157, 162

gases, of, 4, 231

isomerism, 6, 161–162

triple-bond effect, 6, 162

rotation, 3, 281–290

scattering of light, 7, 98–99

size, 7, 164–183

Young's calculation, 5, 278

spectra, 3, 121–135

structure, 1, 4, 154–157, 554; 3, 547

and resistance, 4, 426

velocity, 7, 170–171; 8, 347

velocities, distribution, 5, 353–358

vibrations, 3, 122; 9, 227–228

volume, 2, 480–481; 7, 336

at absolute zero, 6, 8–9

volumes of paraffins, 7, 133

vortices, 6, 371

weight, 2, 480–481

determination, 5, 494

proteins, of, 10, 217, 416, 430–431

tobacco mosaic virus, of, 10, 220

**Molecules,**

anisotropic, 9, 214–215

crystals, in, 1, 293–304

symmetry, 4, 122

definition, 1, 256

electricity, effect of, 1, 256–262

ellipsoidal, 4, 121

length, 9, 227

light,

effect, of, 1, 256–262

scattering by, 2, 261; 7, 98–99;

8, 311–317; 9, 270–280

shape of, 4, 115; 8, 313; 9, 500–510

size of oil, 6, 15

spherical, 4, 116–118

surfaces, on, 9, 1–2

**Moll galvanometer, 9, 225****Molybdenum,**

atomic,

heat, 7, 401

refraction, 2, 541

volume, 7, 401

weight, 1, 500–508 2, 325, 541

boride, 9, 424

carbide, 9, 424

discovery, 2, 316–317

nitride, 9, 424

**Molybdenum—cont.**

silicide, 9, 424

specific heat, 2, 325

X-ray emission, 9, 189–196

**Molybdic acid, 1, 333**

colloidal, 2, 216–217

**Moment, 3, 228**

electric, 9, 201

inertia, of, 9, 226–227

magnetic, 9, 88

**Momentum,**

angular,

conservation of, 6, 368–369

quantisation of, 8, 227

light, of, 2, 9; 8, 514

**Monatomic gas, 5, 335–336**

specific heat ratio, 8, 104

**Monazite, 3, 410**

lead from, 8, 126

mesothorium from, 8, 122

sand, 6, 438

**Mond gas, 7, 417–419****Monkey, 6, 437****Mono-molecular reactions, 7, 248****Monobromo camphor, 8, 288****Monochloroacetic acid, 8, 287****Monochord, 8, 207–210****Monohydrin, 8, 286****Monochromator, 5, 546****Monoclinic crystals, 6, 541–542**

crystals angles, 7, 351

sulphur, 7, 22

symmetry, 7, 330–333

**Monomethyl glucose, 9, 53–54****Monosaccharides, 9, 50****Monosymmetric elements, 7, 128****Montmorillonite,**

ion exchange, 10, 299–300

structure, 10, 288–291

water in, 10, 295–298

X-ray diffraction, 10, 290

**Moon,**

corona, 9, 323

crescent, 6, 123

force on, 6, 289

gravitational effect, 10, 99–100

photographs of, 1, 260

ultraviolet photography, 7, 214–217

**Moonlight, strength, 9, 271****Mordants, 3, 168, 170, 9, 21–22**

sesquioxycidic, 5, 530

- Morogro pitchblende, 8, 125  
 Morphine, 1, 481  
   spectrum, 7, 355, 366-369  
 Morpho,  
   achilles, 9, 261  
   retenor, 9, 261  
 Morphological axes, 1, 294-304; 5,  
   541-550  
 Mortar, 3, 351  
 Moseley's law, 8, 227  
 Motion,  
   absolute, 10, 301-333  
   aether, the, 4, 189-204  
   bodies, of, 4, 248  
   boomerang, of, 1, 118-119  
   Brownian, 7, 174-183  
   celestial bodies, of, 5, 324  
   clouds, of, 4, 249  
   contraction, and, 8, 213  
   copper plate in magnetic field, of,  
     4, 74-77  
   elasticity, and, 3, 136-137  
   energy received, effect on, 4, 197  
   fluids, of, 2, 510-517; 4, 248-257;  
     7, 431-444  
   gyroscopes, of, 1, 115-121  
   heat, and, 1, 196-201; 2, 276, 279;  
     3, 136-137  
   interference, effect on, 4, 197  
   ions in gases, 8, 179-180  
   jelly, of, 4, 248  
   Laplace's equations, 8, 189  
   liquids, of, 1, 131-133  
   locomotive, of, 3, 541  
   medium, of, 4, 190-194  
   molecular, 4, 248-249  
     in crystals, 4, 114-115  
   observer, of, 4, 195  
   pendulum, 1, 13-17, 121  
   perfect fluid, 5, 215-232  
   perpetual, 1, 180-187  
   pictures, 10, 133-134  
   planets, of, 4, 350; 5, 296  
   receiver, of, 4, 190  
   rifled projectiles, 1, 117-118  
   river, in a, 5, 215  
   rotatory, 1, 115-121  
     compaction of, 1, 120  
   sensation of, 8, 212-213  
   source, of, 4, 190, 194  
   surface tension, from, 4, 29-31  
   Motion—*cont.*  
     viscous substances, 6, 67-73  
     vortex, 2, 510-517  
     water, 3, 290-299  
     waves, demonstration of, 6, 11-12  
 Motive power from gas explosions, 4,  
   146  
 Motor,  
   electric, 4, 89-92  
   demonstration, 4, 82-86  
   efficiency, 6, 375-376  
   spirit from coal, 9, 325-356  
 Mottramite, 2, 504  
 Moulding sands, 10, 156  
 Moulds, 6, 36; 10, 339  
 Mountain air, 7, 461  
   gravitation, 4, 351  
   pendulum, 4, 354  
 Mouthpiece, 8, 205  
 Movement,  
   Brownian, 7, 164-183  
   of dust, 7, 164  
 Moving boundary, 5, 493-494  
 Multiphase magnets, 8, 495-509  
 Multiple magnets, 8, 90, 495-501  
 Multiple,  
   accelerator, 9, 498-499  
   columns of bubbles, 8, 148-152  
   plates, reflection by, 8, 282  
   proportions, 6, 90  
   reflection of sound, 3, 494  
 Multitubular boilers, 7, 419-430  
 Murex, 10, 339  
 Murexide, 1, 487  
 Muriatic acid (*see Hydrochloric acid*)  
 Musa paradisiaca, 5, 23  
 Muscae volitantes, 6, 130  
 Muscle,  
   dying, 5, 418  
   effect of injury, 5, 422  
   electric response, 5, 421  
   gastrocnemius, 5, 423  
   response, hydraulic model, 5, 420  
   mechanical response, 5, 417-418  
   nerve, 9, 293  
   protein, 10, 414  
   X-ray diffraction, 9, 454  
 Musical box,  
   effect on flame, 2, 37  
   electric arcs, 5, 500-507  
   instruments, 8, 205-211

**Musical box—cont.**

- notes, 4, 384–393
  - from water motion, 1, 132
- sound, 1, 246–248
- vibrations, 8, 198–211

**Musk** 6, 14

- artificial, 6, 13; 7, 195

**Musophagidae**, 4, 237**Mustard oil**, 1, 274**Mutarotation**, 7, 381–384

- acetyl chloride, effect of, 7, 384
- benzene, in, 7, 384
- bromonitrocamphor, 7, 382
- chloroform, in, 7, 383
- discovery, 7, 381
- ether, in, 7, 384
- glucose, of, 7, 381–384
- gluconic lactone, of, 7, 382
- grape-sugar, of, 7, 381
- kinetics, 7, 383
- nitrocamphor, of, 7, 382
- phargene, effect of, 7, 383–384,
- reducing sugars of, 7, 381–382

**Mutual,**

- inductance, 4, 431
  - calculation, 4, 445
- induction, 3, 301–304
  - demonstration, 3, 95

**Myosine**, 10, 171**Myrica nagi**, 9, 116**Myricetin**, 9, 116**Myristic acid**, 1, 546–547**Myrtle**, 9, 116**Mysorine**, 1, 332**Myxoedema**, 10, 341**Myxoxanthin**, 10, 235

## N

**Nacrite**, 10, 289–290

- X-ray diffraction, 10, 290

**Naphtha,**

- constituents, 3, 363–364
- coal-tar, from, 3, 363
- extinction of phosphorous glow, 4, 15
- preservation of sodium and potassium, 6, 269

**Naphthalene**, 1, 274; 6, 411–413

- analysis, 2, 478–479

**Naphthalene—cont.**

- azide, 7, 201
- C—C distance, 9, 464
- coal, from, 3, 365–366
  - tar, 9, 100
    - 1 ton coal, 3, 365–366
- colour, 6, 415
- crystal structure, 8, 382–384; 9, 257
- density, 6, 6
- discovery, 9, 100
- dyes, 3, 365, 368
- electrical discharge in, 3, 181
- flakiness, 9, 42–43
- infrared transmission, 8, 285
- magne-crystals, 9, 140–141
- magnetic susceptibility, 10, 146
- melting point and pressure, 7, 20–21
- molecular structure, 9, 509
- oxidation, 6, 413
- refractive index, 2, 544–545
- specific heat, 6, 85–87
- spectrum of arc in, 3, 181
- synthesis, 1, 271, 478
- sulphonic acids, 4, 158, 9, 100

**Naphthol,**

- crystal structure, 8, 384
- yellow, 3, 368

**Naphthyl radical**, 2, 186**Naphthylamine**, 7, 200

- diazotisation, 2, 190–192
- formula, 2, 186

**National Physical Laboratory**, 5, 441–452**Natural,**

- biquartzes, 7, 340
- colours, 9, 18–25
  - synthesis, 10, 112–127
- energy, sources of, 7, 375
- films, 9, 109
- gas, 7, 416
  - helium in, 6, 384; 9, 315–317
  - study by Faraday, 9, 95
- indigo, 9, 102
- perfumes, 6, 10–14
- petroleum, 3, 361
- resources, British, 1, 35
- selection, 3, 269

**Nature,**

- conservation of,
  - energy in, 1, 370–380
  - force in, 1, 370–380



**Nature—cont.**

- diffusion, of, 1, 395
- iridescence in, 9, 261–262
- force, of, 1, 227–240
- heat, of, 3, 268–271
- light, dual, 8, 510–519

**Native sulphur, 7, 22****Naval,**

- explosives, 9, 103
- matters, studied by Rumford, 2, 275

**Near infrared wavelengths, 9, 224****Nebulae,**

- condensation, 6, 151
- photography, 8, 312
- planetary, 8, 242
- temperature, 5, 416

**Nebular spectra, 5, 469**

- spectrum of helium, 8, 242

**Needle, magnetic, 1, 25–26****Neodymium, 3, 415****Negative,**

- cathode rays, charge on, 5, 41–46
- crystals, 4, 123
- glow, 9, 122–123
  - effect of magnetic field, 1, 315
- spectrum, 3, 127–128
- pressure, 4, 111
- rays, 3, 40–59
  - effect of magnetic field, 3, 53–54
  - heating effect, 3, 54–57
  - inertia, 3, 57–58
- transparent, 4, 41

**Nemalite,**

- anisotropic conductivity, 4, 24–25
- microwave dichroism, 5, 23

**Nematic liquid crystals, 9, 536–543****Neocyanine, 10, 136–137****Neon,**

- air, in, 5, 466–467; 6, 435; 7, 67, 141, 455–465
- atomic,
  - radius, 8, 329
  - structure, 8, 226
  - weight, 5, 467; 7, 71; 8, 340
- Bath gas, in, 5, 159–160, 468; 7, 67
- boiling point, 5, 467; 7, 71
- density, 5, 467
- diffusion through rubber, 7, 482–486
- discovery, 5, 159–160, 466–467
  - of isotopes, 7, 296
- electric discharge in, 9, 122–130

**Neon—cont.****electric discharge in—cont.**

- from, 7, 402–404
- electronic structure, 8, 327
- glow discharge, 5, 468
- high temperature diffusion, 7, 469
- hydrogen spectrum, effect on, 8, 241
- isolation, 6, 113–115, 226–228
- isotopes, 8, 334–340
  - separation of, 8, 334–335
- light scattering, 9, 274
- like ions, radii, 9, 80
- mass-charge,
  - ratio, 7, 296
- spectrum, 8, 336–337
- melting point, 7, 141
- nuclear fission, 9, 15–16
- occurrence, 7, 455–465
- pressure at melting point, 7, 141

**Neopentane, 2, 482, 486****synthesis, 2, 489–492****Neptunium, 10, 254–255****Nernst and Lindemann's experiment,**

8, 104–106

**filament, 7, 47, 240****theorem, 10, 97****Neroli, oil of, 6, 11, 13****Nerve centres,**

- electrical response, 5, 433
- optic, 5, 419
- potassium hydroxide, response,
  - effect of, 5, 438
- radium, effect of, 6, 49
- ultrasonics, effect of, 9, 293–295
- X-ray diffraction, 9, 454

**Neumann's law, 5, 192****Neutral,**

- colloid, 9, 71
- micelles, 9, 64–72
- point, thermoelectric, 6, 540
- salts, 1, 329

**Neutralisation,**

- acid-base, 1, 75; 6, 96
- heat of, 6, 96, 102
- volume change, 6, 102

**Neutrons,**

- atoms collision with, 9, 416–418
- beryllium, from, 9, 415–418, 496; 10, 108–111
- bombardment, 9, 496; 10, 253–256
- capture, 9, 496

**Neutrons—*cont***

- cloud chamber, in, 9, 416
- discovery, 9, 415-418, 496, 10, 108
- mass, 9, 416, 10, 109
- production of artificial isotopes, 10, 109-111
- recoil, and, 9, 415-418
- slowing, 10, 254
- source, 10, 254
- velocity, 9, 416

**New stars, 8, 237, 243****Newlands' periodic law, 2, 404****Newton,**

- constant of gravitation, 4, 350-374
- mechanics and chemistry, 3, 540-559
- prophecies, 1, 147
- radiation law, 5, 237-240
- rings, 2, 374-375, 3, 232, 8, 512-513
  - acoustical analogy, 4, 241
  - measuring elasticity, for, 3, 60-62
  - optical contact, and, 10, 204-208
  - photography of, 3, 62, 4, 42
  - sodium light, from, 4, 242
- table of colours, 3, 320
- theory of fits, 8, 513-514

**Niagara falls, 6, 375****Nicholson's doubler, 3, 467-466****Nichrome wire furnace, 7, 239****Nickel,**

- abundance, 10, 272
- ammoniacal sulphate, 1, 225
- atomic,
  - heat, 5, 190-195, 7, 401
  - radius, 8, 326
  - refraction, 2, 541, 4, 211-212
  - spectrum, 7, 357-359
  - volume, 7, 401
  - weight, 1, 500-508, 2, 325, 541, 5, 190, 195
- bacteria, action on, 7, 86-92
- bromide,
  - anhydrous, 2, 428
  - hydrate, 2, 429
  - solution, 2, 428-434
- calcium sulphide, in, 9, 223
- carbonate, 4, 210
  - artificial photosynthesis, in, 9, 195
  - preparation, 9, 195
- carbon monosulphide, reaction with, 7, 152

**Nickel—*cont***

- carbon monoxide, reaction with, 4, 208
- carbonyl, 4, 208-211
  - carbon disulphide, reaction with, 7, 143
  - diamagnetism, 4, 210
  - flame, 4, 210
  - formula, 4, 212
  - hydrogen-oxygen flame spectrum, 4, 210-211
  - magneto-optical properties, 4, 211
  - nickel extraction, use in, 4, 215-216
  - nitric oxide, reaction with, 4, 210
  - oxidation in air, 4, 210
  - physiological action, 4, 209
  - preparation, 4, 208-209
  - properties, 4, 209
  - spectrum, 4, 210
  - thiophosgene, 7, 143
- catalyst for deuterium substitution, 10, 63-64
- chloride, 7, 143
  - osmosis, 2, 217
- discovery, 2, 315-316
- ductility, 6, 425
- eddy currents, 3, 306-311
- electron diffraction, 9, 191
- extraction, 4, 215-216
- ferroniagnetism, 9, 88
- filings in magnetic field, 8, 489-509
- film, 6, 382
- finely-divided, 4, 208
- heat and magnetism, 4, 11-12
- hydrogenation catalyst, 10, 63-64
- hysteresis, 8, 508
- iodide
  - anhydrous, 2, 428
  - hydrate, 2, 429
  - solution, 2, 428-434
- isomerism of compounds, 5, 195-196
- lead thermocouple, 4, 538
- low-temperature resistance, 4, 230
- magnetic properties, 1, 195, 4, 10, 535, 9, 88
  - and stress, 3, 18-20, 4, 134
- magneto-optical properties, 5, 175
- magnetostriction, 10, 460-461
- mirrors, 7, 213
- ore in magnetic field, 8, 495-509

**Nickel—*cont.***

- oxalate, 3, 445
  - finely divided, 4, 208
  - oxide, 1, 161
    - combustion catalysis, 1, 406
  - periodic table, position in, 7, 452
  - permeability, 4, 10
  - permanganate, 6, 100
  - peroxide, 1, 282
  - photographic plates, action on, 5, 257–258
  - phthalocyanine, 10, 224–225
  - planes of force, 8, 505–506
  - potassium sulphate, 1, 329
    - crystal structure, 7, 351
  - resistance and temperature, 4, 524–527
    - at low temperature, 4, 230
    - in magnetic field, 4, 535
  - silver, emissivity, 8, 290
  - specific heat, 2, 325; 5, 190–193
  - square-planar, 9, 503
  - steel, 4, 158
    - Faraday's work, 9, 97
    - magnetisation, 4, 541–548
    - resistance, 4, 525–529
  - sulphate,
    - dichroism, 4, 509
    - magnetism, 1, 79
    - seeding, 3, 398
    - supersaturation, 3, 399
  - sulphide, 7, 143
  - sun, in, 1, 357, 433
  - temperature, effect, of, 6, 425
  - tensile strength, 6, 425
  - trace in explosion, 3, 446–450
  - vacuum vessels, 6, 218
  - Villari effect, 3, 19–20; 4, 11
  - X-rays, 7, 451
  - Young's modulus, 8, 354–355
- Nicol prism**, 2, 169, 357, 394; 3, 519; 5, 543
- construction, 3, 522
  - modifications, 3, 523
- Nicotine**,
- infrared transmission, 8, 288
  - phosphorescence, 4, 377
- Night**,
- blindness, 10, 237
  - green, 2, 188–189

**Night—*cont.***

- sky,
    - luminosity, 9, 270–271
    - polarisation of, 8, 313–314
- Nitella**, 9, 293–294
- Niton**, 8, 226
- Nitrate ion**, structure, 9, 81
- Nitrates**, 1, 332–333
- basic, 2, 333
  - formulae, 2, 205
  - production from atmosphere, 6, 181–182
  - reduction by zinc-copper couple, 2, 441
- Nitration of benzene**, 3, 363
- Nitre production 1906**, 6, 181
- Nitric**,
- acid, 1, 75, 206, 333; 7, 195
    - action on charcoal, 6, 231
    - battery, 1, 32
    - biosynthesis, in, 1, 272
    - hydrochloric acid mixtures, 2, 268
    - magnetism, 1, 68
    - maximum conductivity, 5, 491
    - nickel carbonyl, reaction with, 4, 209
  - phosphorescence, 4, 377; 5, 461
  - production, 6, 182
  - viscosity, 2, 212–213
- oxide**,
- afterglow, 9, 222
  - carbon,
    - disulphide explosion, 2, 19
    - flame, 2, 152, 9, 469–473
    - velocity, 4, 143
    - vibrations, 4, 143
  - carbon arc in, 3, 177
  - catalysis, 1, 162
  - cyanogen flame, 3, 180
  - liquefaction, 9, 98
  - liquid,
    - colour, of, 4, 462
    - magnetism of, 4, 462
    - properties, 4, 462
  - nickel carbonyl, reaction with, 4, 210
  - nitrogen from, 4, 398
  - oxygen, reaction with, 4, 462
  - paramagnetism, 4, 220
  - phosphorescence, 4, 462
  - purification, 4, 462

**Nitric—*cont.*****oxide—*cont.***

ratio of heat capacities, 6, 337

solid, 4, 462

viscosity, 2, 219–221

X-ray absorption of liquid, 5, 160

Nitrides, superconductivity, 9, 424

Nitriles, 8, 288

Nitrites, 3, 80–81

Nitro-compounds,

colour, 2, 182

infrared transmission, 8, 283, 288

cotton, 8, 1–6

solutions, viscosity, 9, 173–181

structure, 9, 259

Nitrobenzene, 1, 274; 3, 370

hydrogen sulphate, 10, 349

industrial,

production, 1, 569–570; 3, 364

reduction, 1, 570

infrared transmission, 8, 288

perfume, as, 3, 372

preparation, 1, 406, 452

reduction, 1, 407

synthesis, 2, 145; 3, 363.

Nitrobenzoic acid, 3, 165

Nitrobenzonitrile, 3, 165

Nitrobutane, 2, 172

Nitrocamphor, 7, 382

Nitrocellulose, 8, 1–6

solutions, viscosity, 9, 173–181

structure, 9, 259

Nitrocinnamic acid, 2, 166–167

**Nitrogen,**

acetylene mixtures, electrical discharge in, 2, 198

active, 7, 306–311; 8, 475–487; 9, 222

afterglow, 9, 222

animal pigments, from, 4, 235

argon, in, 4, 447–449

atomic,

heat, 7, 401

radius, 8, 326; 9, 502

refraction, 2, 138, 541; 6, 163

structure, 8, 221–226

volume, 5, 213, 323; 7, 337, 401

weight, 1, 500–508; 2, 514; 8, 340

atoms, 7, 306

instability, 4, 398

Bath gas, in, 7, 67

**Nitrogen—*cont.***

boiling,

point, 4, 106; 6, 75–77

water, from, 1, 467–474

capture of  $\alpha$ -particle, 9, 75–76

carbon arc in, 3, 177

carbon monoxide combustion, effect

on, 8, 475–487

charcoal, adsorption by, 6, 105, 384, 395–404

chemistry, 1, 206–213

critical constants, 3, 315

temperature, 6, 75

cryophorous, 5, 316

density, 4, 397–400

charcoal, in, 6, 218

liquid, of, 4, 463; 6, 8–9; 6, 77

solid, of, 6, 428

temperature, and, 6, 75

diamagnetism, 4, 220

diffusion through,

graphite, 2, 41–44

rubber, 2, 38–44, 229 233; 7, 471–486

dioxide,

afterglow, 9, 222

bleaching, 2, 363

dimerisation, 9, 221

discharge, in, 7, 70

spectrum, 1, 384

viscosity, 5, 141–149

discharge in, 4, 287

discovery, 2, 315–316; 4, 400

effusion rate, 2, 40–44, 224–229

electrical discharge in moist, 3, 199–200

electroluminescence, 7, 67–70

electronic structure, 8, 486–487

of active, 8, 486–487

electronics, number of, 8, 58

evaporation temperature, 6, 75; 7, 226

fixation, 3, 28–29

in arc, 6, 181

flame velocity, effect on, 4, 146–147

freezing in hydrogen stream, 6, 76

heat of adsorption on charcoal, 6, 109–110

hydrogen jelly, 4, 468

reaction, 8, 294

infrared absorption, 1, 349

**Nitrogen—cont.**

- iodide,
  - decomposition, 1, 135, 159
  - discovery, 9, 94
- ion 7, 186–188
- isotherm adsorption, 6, 254
- isotopic labelling, 10, 69–70
- jelly, 4, 460
- latent heat, 6, 77, 431
- light scattering, 8, 311; 9, 275
- limiting density, 5, 322–323
- liquefaction, 3, 27; 4, 221
- liquid,
  - demonstration of, 5, 313
  - expansion of, 5, 323
- magnesium arc in, 3, 187–188
- magnetism, 1, 68
- mass spectrum, 7, 188–191
- melting point, 7, 141
- mercury,
  - compound, 7, 311
- process, estimation of, 3, 87
- molecular volume, 6, 8–9
- molecule ion, 7, 186–187
- $N_3$ , 4, 410–411, 453
- negative band spectrum, 8, 371
- neutron capture, 9, 496
- nuclear fission, 9, 13–16, 417
- occlusion by,
  - gold, 2, 47
  - silver, 2, 48
  - pressure, 6, 254
- optically active compounds, 6, 33–34
- oxides,
  - electrical discharges in, 1, 473
  - formation in electrical arcs, 2, 86
  - formulae, 2, 131
- oxygen radiometer, 6, 258
- p.V.T data, 5, 363
- $\alpha$ -particle bombardment, 9, 495
- pentoxide dissociation, 7, 100
- positive band spectrum, 8, 371
- preparation, 4, 397–398
- pressure at melting point, 7, 141
- production, 6, 383
- proteins, in, 9, 193
- protoplasm, in, 7, 61
- reaction with acetylene, 3, 82
- reactions of active, 7, 309–311
- recoil, 8, 246

**Nitrogen—cont.**

- refraction of compounds, 6, 165
- refractive index of liquid, 4, 259
- removal, 4, 455
  - by magnesium, 4, 403
- separation from oxygen by magnetism, 1, 2–3
- silicon compounds, 7, 59–60
- solid, 4, 233, 5, 284; 7, 138–141
- sound from radiation, 3, 152
- spectrum, 1, 512; 4, 448–449
  - active, of, 7, 309
  - discharge, 8, 370–371
  - liquid, 7, 82
- sulphur compound, 7, 34
- tantalum, adsorption by, 7, 50–51
- trichloride, 1, 448; 9, 94
  - instability, 3, 548
- ultraviolet,
  - absorption, 1, 430–431
  - spectrum, 3, 259–260, 264–265
- valency, 1, 549–554; 8, 328
- viscosity, 2, 219–221
- Nitroglycerine, 7, 195
- Nitromethane, 8, 288
- Nitroschlorides, 7, 202
- Nitrous,
  - acid, 1, 75, 206, 259, 271
    - action on,
      - ammonia, 7, 197
      - aniline, 7, 199
      - hydrazine, 7, 197
      - phenylhydrazine, 7, 200
    - discharge, in, 7, 70
- oxide,
  - adsorption by charcoal, 6, 105, 395
  - carbon monoxide flame velocity, 4, 145
  - critical constants, 3, 315
  - Davy's work, 6, 263
  - dissociation, 3, 474
  - hydrogen flame velocity, 4, 145–146
    - reaction, 7, 102
  - impurities, 3, 23
  - infrared absorption, 1, 349, 463–466; 4, 259
  - liquefaction, 3, 23; 4, 160
  - liquid, 3, 312–313; 4, 457
  - molecular refraction, 4, 231

**Nitrous—*cont.*****oxide—*cont.***

- nitrogen from, 4, 398
- oxygen liquefaction, use in, 4, 218
- ratio of heat capacities, 5, 337
- refractive index, 4, 231
- sodamide, reaction with, 7, 197
- solid, 3, 25; 4, 160
- soldification, 9, 98
- sound from radiation, 3, 152
- spectrum, 3, 512
- X-ray absorption of liquid, 5, 160

Nitropentane, 2, 161–166, 172

Nitrophenylacetic acid, 3, 165

Nitrophenylglyoxylic acid, 3, 165

Nitrophenylpropionic acid, 3, 167–173  
cost, 3, 167

Nitrophenols, 7, 363–364

Nitrosates, 7, 202

Nitrotoluene,

- infrared transmission, 8, 288
- production, 3, 364

Nodes,

- sound, 3, 456–458
- string, of, 2, 22
- tympaum, of, 1, 246
- vibrating rod, of, 2, 24

Noise from arcs, 5, 500–507

Non-

- aqueous solvents, 5, 498
- Euclidean space, 8, 190–197
- laminar flow, 3, 295–297
- linearity and combination tones, 4, 386
- metals, electronegativity, 5, 562
- reducing methylated glucoses 9, 53–54

Nonane, 2, 390

- silicon-substituted, 2, 390

Nonene, 2, 145

Nonyl alcohol, 2, 390

- silicon-substituted, 2, 390

Nonylamine, 2, 145

Northumberland pipes, 1, 107

Norwegian clevite, 8, 126

Notes, open, 8, 206

- musical, 4, 384–393

Nozzles for film jets, 8, 413–414

Nuclear,

- atom, theory of, 8, 130–135
- charge, 8, 131

**Nuclear—*cont.*****Charge—*cont.***

- atomic number, and, 8, 133
- $\alpha$ -particle scattering, and, 8, 248
- X-rays, and, 9, 6–16
- collisions, 8, 536
- fission, 9, 13–16
- radius, 9, 8–10
- reactions, 10, 22–27
- recoil, 8, 536
- structure, 8, 341
- and radioactivity, 9, 10–12
- of deuterium, 10, 21

Nuclei,

- condensation, 6, 62–66
- forces between, 9, 8–10

Nucleus,

- atomic, 7, 502; 9, 6–16, 73–76
- capture of  $\alpha$ -particles, 9, 75–76
- disintegration of nitrogen, 9, 417
- helium, 8, 520
- isotopes, and, 8, 114
- $\gamma$ -rays from, 9, 12–13
- stability of helium, 9, 314
- vibration frequency, 9, 12–13

Number,

- atomic, 7, 452
- Avogadro's 7, 164–183
- carbon compounds, of, 9, 18
- electrons in shells, of, 8, 327
- Numbers, transport, 5, 490–491
- Numerical aperture, 6, 128–130
- Nutrition of plants, 5, 372

**O**

Oak, rubidium in, 2, 320

Obdurating pads, 8, 349

Object lens,

- achromatic, 1, 122
- aperture angle, 1, 122–123

Objective,

- focal length, 6, 125
- microscope, 4, 184; 6, 125
- projection, 4, 185

Observables, 10, 301–331

Observer motion, 4, 195

Obstacles in electric discharges, 4, 283–284

Ocean, colour, 2, 254–264

**Occlusion,**

- gas and density, of, 2, 237-239
- metals, by, 2, 45-49, 233-239
- palladium alloys, by, 2, 237-239
- pressures, 6, 254-255
- theory, 2, 49

**Occurrence of elements, 7, 55****Octahedral structure, 9, 504****Octahedron, 1, 290; 4, 118****Octane, 4, 384**

- formula, 1, 545; 2, 480-481, 486
- from coal, 1, 399
- infrared transmission, 8, 285
- viscosity, 6, 141-154

**Octene, 2, 145****Octyl alcohol, 1, 546****Octylamine, 2, 145****Odd elements, 9, 16****Odour of anise, 7, 202****Oenanthylene, 1, 399****Oenidin, 9, 115****Oenin, 9, 115****Ohm,**

- absolute, 4, 426-446; 6, 361
- international, 4, 521
- standard, 3, 92; 4, 427
- unit, 3, 92

**Ohm's law, 4, 426**

- electrolysis, in, 5, 486
- flames, in, 7, 3

**Oil,**

- antropogon, of, 6, 10
- bitter almonds, of, 1, 272; 3, 372
- coal, from, 1, 34-41; 9, 325-356
- cod, 9, 98
  - liver, 8, 375, 377
- colours, 9, 261
- diffusion pump, 9, 243-244
- emulsification, 9, 292
- essential, 6, 10-14
  - and phosphorous glow, 9, 27
- films, 9, 109
  - thickness, 4, 30-31
    - on water, 3, 298; 4, 28-34; 9, 110-113
  - thickness, 8, 40
- garlic, of, 1, 274
- high frequency insulator, 4, 172-173
- indicator, 10, 422-427
- iris, of, 6, 11
- jasmin, of, 6, 11, 13

**Oil—cont.**

- lavender, of, 6, 11
  - lemon,
    - grass, 6, 12
    - magnetism, of, 1, 68
    - optical activity, of, 3, 516; 7, 380
  - linseed, 1, 68
  - molecular,
    - size, 6, 15
  - structure, 9, 1
  - mustard, of, 1, 274
  - neroli, of, 6, 11, 13
  - non-conductor, 5, 559
  - olive, 1, 68
  - photographic plates, action on, 5, 259
  - production from coal, 1, 34-41; 9, 325-356
  - refractive index, 6, 166
  - saponification, 9, 72
  - tuberculosis, 6, 11
  - turpentine, 1, 452
    - effect on phosphorus glow, 2, 209
    - reaction with bromine, 2, 188
    - ultraviolet absorption, 1, 430-431
  - ultrasonic waves in, 9, 285-289
  - water, effect on surface tension of, 4, 31-32
  - waves, effect on, 4, 32-33
  - whale, 9, 98
  - wintergreen, of, 1, 274; 2, 195
  - X-ray diffraction, 9, 1
- Oleates, 8, 388-448**
- Olefiant gas (see Ethylene)**
- Olefines, 2, 193**
- azides of, 7, 201-202
  - molecular refraction, 6, 156-162
  - preparation, 1, 271; 2, 440, 498
  - production of acetylene from, 2, 143
- Oleic acid, 8, 388-389**
- film, 9, 40
    - on water, 9, 40, 111-112
  - infrared transmission, 8, 287
  - length of molecule, 9, 40-42
  - structure, 10, 449-450
  - surface concentration, 9, 111-112
- Olive oil,**
- action on photographic plate, 5, 259
  - film, 8, 1
  - magnetism, 1, 68
- Olivine, 1, 331**
- graphite reaction, 8, 303

- Opacity, 5, 253-256  
   of air, 5, 404  
 Opal,  
   blue, 2, 188  
   constitution, 7, 57  
   fiery, 3, 495  
   glass, 2, 20; 9, 160  
   iridescence, 3, 493  
 Opalescence,  
   atmosphere, of, 2, 13  
   critical, 2, 295-297; 9, 276  
   liquids, of, 9, 275-276  
 Opera glasses, 5, 452  
 Ophthalmoscope, 4, 394  
 Opium, 7, 364  
 Optic,  
   axis, 1, 5-6, 298-304; 9, 283  
   nerve, 5, 419  
 Optical,  
   activity, 1, 7-8; 3, 516-539; 6, 98  
   artificially produced, 3, 532  
   compressed crystals, of, 4, 124  
   demonstration, 6, 31  
   silicon compounds, of, 7, 59  
   compass, 4, 361-364  
   contact, 2, 374-375; 10, 201-213  
   adhesion, 10, 203-204  
   dust, 3, 232  
   Newton's rings, 10, 204-208  
   ellipsoid, 5, 541-550; 7, 327-328  
   experiments in sodium light, 3, 11-17  
   flatness, test for, 4, 242-247  
   flats, 5, 392  
   glass, 2, 56-57; 5, 444-445; 9, 104  
   isomers, 6, 29-39  
     resolution, 6, 32-34  
     spectra, 7, 364  
   lever, 8, 208  
   opacity of air, 5, 404  
   polishing, 5, 392-403  
   projection, 4, 183-188  
   properties of,  
     air, 8, 308-317  
     amethyst, 1, 6  
     crystals, 1, 293-304; 2, 357-361;  
       5, 541-550; 9, 547-550  
     Hertzian waves, 4, 345-348  
     organic compounds, 1, 483-491  
     quartz, 7, 339-340  
     tourmaline, 1, 5-6  
   pyrometer, 7, 238  
 Optical—*cont.*  
   torque, 3, 516-539  
 Optics,  
   crystals, of, 1, 293-304; 2, 357-361;  
     5, 541-550; 9, 547-550  
     dynamics, and, 9, 206  
       length measurement, 3, 229  
   electrons, of, 9, 357-364  
   Helmholtz's work, 4, 393-396  
   mineralogy, in, 1, 304  
   physiological, 4, 384  
   soap films, of, 3, 320  
   Young's work, 5, 278  
 Oran eclipse, 2, 254-256  
 Orange I-IV, 3, 368  
   yellow, 3, 368  
 Orbit of mercury, 8, 102, 190-191  
 Orbital revolution frequency, 8, 224  
 Orbits,  
   electrons, of, 8, 59  
   planetary, 8, 224-226  
 Ore, Sudbury, 8, 495-509  
 Order-disorder theory, 10, 226  
   of reaction, 7, 248  
 Organ pipe, 3, 1  
   harmonics, 8, 103  
 Organic,  
   acids, 1, 74-77  
   azides, 7, 198-204  
   chemistry, 1, 90, 205  
     definition, 1, 141  
   compounds,  
     classified, 1, 574  
     number, 9, 18  
     optical properties, 1, 483-491  
     radioluminescence, 6, 41  
     spectra, 3, 174-186; 7, 355-370  
   crystals, structure, 8, 378-385  
   groups, 1, 90  
   halides, reaction with sodium azide,  
     7, 202  
   matter, luminescence of decaying, 4,  
     375  
   nitrogen compounds, 7, 195-204  
   radicals, 1, 90, 154-155, 207-213;  
     2, 186  
   sulphates, 1, 329  
   synthesis, 1, 270-276, 415-482; 2,  
     140-147  
 Organisms, chemistry in, 8, 26-31



- Organo-metallic compounds**, 1, 271, 535-538
- Origin of**,  
  earthquakes, 8, 292  
  elements, 3, 403-426  
  life, 2, 304; 4, 222; 6, 35  
    Tyndall's work, 4, 281  
  radium, 7, 247-265  
  species, 3, 269  
  X-rays, 7, 491
- Orion**, 8, 39  
  spectrum, 1, 433-434
- Orthoaminobenzoic acid**, 3, 163
- Orthocarbonic acid**, 1, 333
- Orthochrome T**, 10, 130
- Orthochromatic plates**, 10, 129
- Orthoclase**, 4, 55  
  microwave birefringence, 5, 22
- Orthoformic ester**, 10, 130
- Orthonitrates**, 1, 333
- Orthonitric acid**, 1, 333
- Orthorhombic elements**, 7, 128
- Orthophosphates**, 2, 502
- Orthosilicates**, 1, 331-332
- Orthovanadates**, 3, 502
- Orthoxylene**, viscosity, 5, 142-154
- Oscillating**,  
  disc viscometer, 9, 169-170  
  voltage, physiological effect, 4, 334
- Oscillations**,  
  current in induction coil, of, 1, 177-179  
  damping in tin, 8, 358  
    of electrical, 3, 484  
  electrical, 3, 483  
  high frequency, 7, 266-293  
  LC, 5, 503  
  properties of quartz fibres, 4, 361  
  waterjet, of, 4, 34-35
- Oscillator**,  
  arc, 7, 285-293  
  demonstration, 5, 12-13  
  electromagnetic, 4, 18-19  
  Hertz, 4, 325  
    large, 6, 330  
  high-frequency, 10, 172  
  microwave, 5, 14-17  
  valve, 9, 282
- Oscillators**, 4, 331
- Oscillatory discharge**, 3, 489
- Osmium**,  
  atomic,  
    heat, 7, 401  
    refraction, 2, 541  
    volume, 7, 401  
    weight, 1, 500-508; 2, 325, 541  
  discovery, 2, 316-318  
  filament, 7, 47  
  medical use, 7, 47  
  properties, 1, 352-353  
  specific heat, 2, 325  
  tetroxide, 3, 551  
  world production, 7, 47
- Osmosis**, 5, 494  
  colloids, of, 9, 64-67  
  discovery, 7, 5  
  Graham's work, 2, 217-218  
  laws of, 7, 6  
  membranes, 2, 217  
  soap jellies, of, 9, 71  
  solutions, 9, 64-67  
  solution, in dilute, 7, 6  
  van der Waals equation, 7, 7  
  vapour pressure theory of, 7, 7-13
- Osmotic pressure**, 6, 96; 7, 5-15  
  and temperature, 7, 6-7
- Otto engine**, 3, 216-217
- Ovens**, 2, 276
- Overgrowths**, 7, 328
- Oxalic acid**, 1, 158, 333  
  amyl, ethyl, 1, 521  
  biosynthesis, 3, 549  
  density, 6, 6  
  dimethyl, 1, 520  
  expansion, 6, 6  
  formula, 1, 575  
  kinetics of oxidation, 2, 134  
  reaction with metal-organic compounds, 1, 519  
  synthesis, 1, 142, 237
- Oxazines**, 5, 533
- Oxidation by ozone**, 1, 23; 2, 362-364  
  kinetics, 2, 124  
  on metal wires, 6, 300
- Oxidase**, 10, 338
- Oxidising agents in photography**, 4, 44
- Oxides**,  
  catalysis by, 1, 159-163  
  cathode, 6, 167  
  contact electricity, 5, 56  
  films, contact electricity, 5, 56

**Oxides—cont**

- films, contact electricity—*cont*
- on steel, 3, 237–238
- hydrochloric acid, action of concentrated, 6, 95
- magnetic, 1, 528
- nitrogen, of, 1, 473, 2, 86
- phosphorous, of, 4, 16–17
- sols, 10, 148
- vanadium, 2, 126–129
- X-ray absorption, 4, 487

**Oxonium salts, 10, 119****Oxy-**

- acetylene flame temperature, 7, 237
- acids, 1, 74–75
- hydrogen blowpipe, 9, 96
- salts, 2, 205

**Oxycyanines, 10, 138****Oxyhaloid theory, 4, 45–46****Oxygen,**

- absorption band width, 4, 232–233
- abundance, 10, 272
- acetylene,
  - compression, 8, 303
  - flame temperature, 7, 237
- acids, in, 5, 55–56
- afterglow, 9, 222
- alcohol flame, 1, 89
- allotropy, 1, 56–58
- atmospheric spectrum, in, 4, 219–220
- atomic,
  - heat, 7, 401
  - radius, 8, 326, 9, 502
  - refraction, 2, 138, 541, 6, 163
  - structure, 8, 221–226
  - volume, 5, 213, 323, 7, 337–401
  - weight, 1, 445, 500–509, 2, 541, 8, 340, 10, 17, 47
- atoms, 7, 188
  - in flame, 8, 473–475
  - production, 3, 473–475
- autoionised, 1, 282–283
- band intensity and concentration, 5, 1–4
- Bath gas, in, 5, 158
- boiling point, 4, 106, 218, 6, 77, 7, 237
- carbon monoxide,
  - explosion, 6, 301
  - reaction, 7, 100
  - hydrogen explosion, 1, 128

**Oxygen—cont**

- catalytic reaction with hydrogen, 1, 159, 2, 72, 6, 395, 8, 28, 9, 399
- charcoal,
  - adsorption on, 6, 105, 384, 395–404
  - isolation by, 6, 111–113
- colour, 6, 416–417
  - concentration in liquid air, and, 4, 233
  - liquid of, 4, 161
- critical constants, 3, 315
- density, 2, 154
  - charcoal, in, 6, 218
  - liquid, of, 4, 462, 6, 1, 2, 8, 9, 77
  - solid, of, 6, 428
  - temperature, and, 5, 323
- dielectric,
  - breakdown, 4, 219
  - constant of liquid, 5, 462
- diffusion through
  - black films, 8, 173–176
  - graphite, 2, 41–44, 224–229
  - rubber, 2, 38–34, 229–233, 7, 471–486
- discovery, 2, 315–316
- dissociation in flame, 8, 473
- earth's crust, in, 7, 54
- effusion rate, 2, 40–44, 224–229
- electrical,
  - conduction, 4, 219
  - discharge in, 2, 154, 4, 287
  - moist, 3, 199–200
- electrochemical equivalent, 2, 75
- electroluminescence, 5, 464–465, 7, 67–70
- electronegative character, 1, 138
- electrons, number of, 8, 58
- evaporation,
  - rate of, 4, 224–225
  - temperature, 7, 226
- formation of, 1, 94–95
- heat of adsorption on charcoal, 6, 109–110, 255
- heavy, 10, 68–69
- hydrogen,
  - explosion, 2, 422–423, 440–443
  - by infrared, 1, 533
  - flame, 1, 89
  - heating effects, 2, 148–150

**Oxygen—cont.****hydrogen—cont.****flame—cont.**

temperature, 1, 432, 7, 237

under pressure, 2, 153

velocity, 6, 300; 7, 409

reaction, 5, 561–562

catalysed, 9, 399

by platinum, 1, 159; 2, 72;  
8, 28

on charcoal, 6, 395

identical to ozone, 2, 362, 364–365  
infrared,

absorption, 1, 349, 382

of liquid, 4, 233, 259

emission, 1, 381

ion 7, 186–188

radius, 9, 80–86

isotopes, 10, 15, 68–69

isotopic labelling, 10, 68–70

latent heat of evaporation, 4, 218,  
264; 6, 77, 88–89, 431

light scattering by, 8, 311; 9, 275

limiting density, 5, 322–323

liquefaction, 3, 26–27; 4, 161, 218,  
457–458, 463–464; 6, 383**liquid,**

charcoal action on, 4, 463

chemical action of, 4, 221

glowing wood action on, 4, 233

combustion in, 4, 463

demonstration of, 5, 313

expansion of, 5, 284, 323

filtering of, 4, 218

permeability of, 5, 4–10, 462

production of, 6, 383

properties of, 4, 218; 5, 1–10, 454  
–455

removal from solid air, 4, 460

specific heat, of, 4, 266; 5, 284

sulphur burning, in, 4, 233–234

surface tension, of, 4, 218

transformer core, 5, 5–10

X-ray absorption of, 5, 160

magnetism, 1, 1–3, 9–12, 68–69; 2,  
96–101

demonstration of, 4, 220–221

of liquid, 4, 161, 218–222; 5, 4–10

melting point, 7, 141

**molecular,**

refraction, 4, 231–232

**Oxygen—cont.****molecular—cont.**

spectrum, 3, 510–515

volume, 6, 8–9

molecule ion, 7, 188

neutron capture, 9, 496

nitric oxide, action on, 4, 462

nitrogen radiometer, 6, 258

from, 9, 76

O<sub>8</sub>, 7, 188**occlusion,**

platinum, by, 5, 56, 82–83

pressure, 6, 254

silver, by, 2, 47–48, 233–239

occurrence, 9, 245

with depth, 7, 554–555

ozonisation by radium, 5, 512

ozonised (*see Ozone*) $\alpha$ -particle bombardment, 9, 15–16persistence of discharge in, 1, 312–  
313

phosphorous glow, and, 9, 26–27

photochemical oxidation by, 1, 24

preparation of compressed, 4, 457

pressure at melting point, 7, 141

protoplasm, in, 7, 61

quadrivalent, 6, 163

radiation, sound from, 3, 152

rarefaction with height, 7, 173

ratio of heat capacities, 5, 337

recoil, 8, 246

reactions below flame temperature,  
4, 299–300reactions in the absence of water, 7,  
100

refractive index, 4, 231–232

removal, 4, 455

**separation,**

isotopes, of, 10, 68–69

nitrogen, from, 1, 2–3; 2, 96–101

solid, 4, 477; 5, 314, 466–467; 7,  
138–141

solidification attempts, 4, 460

spectrum, 4, 219; 5, 1

of liquid, 4, 161, 219; 5, 1; 7, 82

sulphur flame, 1, 88

thermometer, 7, 224

turpentine, action on, 1, 24

**ultraviolet,**

absorption, 1, 430–431; 5, 2–3

light on solid, action of, 7, 135–153

**Oxygen—*cont.***

- vapour pressure and temperature, 7, 67
- viscosity, 2, 219–221
  - and temperature, 5, 248
- X-ray absorption of liquid, 5, 160
- Oxyquinoline, 3, 370
- Oyster-shell, phosphorescence, 1, 309
- Ozone, 1, 22–24, 282–283, 289; 2, 362–371
  - atmosphere, in, 8, 316–317
  - belt, 8, 316–317
  - bleaching action, 1, 23; 2, 363
  - carbon disulphide, action on, 7, 145–153
  - chemiluminescent reactions, 9, 219–220
  - chlorine, comparison with, 1, 23
  - colour, 6, 416–417
  - condensed form of oxygen, 2, 362, 365
  - decomposition, 1, 24
  - discovery, 2, 362
  - formula, 2, 368–371
  - fluorine and water, from, 5, 96
  - infrared absorption, 1, 350, 392
  - ion, 7, 188
  - instability, 4, 398
  - liquefaction, 7, 135–137
  - liquid, 4, 161
  - oxidation by, 1, 23; 2, 362–364
    - ethane, of, 6, 304
    - silver, of, 7, 137
  - oxygen from combustion in, 4, 463
  - identical to, 2, 362, 364–365
  - paraffin inert, to, 2, 364
  - phosphorescence, 3, 472–475
  - phosphorous glow, from, 4, 15
  - photochemical production in atmosphere, 1, 258
  - production, 1, 94–95
    - electric discharge, by, 1, 22
    - electrolysis, in, 1, 22
    - heat, by, 3, 474–475
    - radium, by, 5, 512; 6, 49
    - ultraviolet light, by, 7, 83
  - properties, 1, 22–24; 3, 472
  - smell, 1, 22
  - solution in carbon disulphide, 7, 135
  - spectrum, 3, 510–515
    - solar, and, 8, 314–317

**Ozone—*cont.***

- structure, 1, 23–24
- Tesla coil discharge, from, 4, 170
- test for, 1, 22
- toxicity, 1, 23
- ultraviolet absorption, 8, 315
- volume change during decomposition, 2, 362, 367–371
  - oxidation, 2, 362, 367–371
- Ozoniser, 7, 135–137
  - Siemen's, 8, 315
- Ozonometric test, 1, 22

**P**

- P-V isotherms for water, 4, 106–109
- Pachoult, 3, 156
- Packing,
  - in, crystals, 4, 116–118
  - of shot, 3, 352
- Pads, obdurating, 8, 348
- Paint, luminous, 3, 252
- Palaeozoic, 8, 112
- Palladium,
  - alloys, occlusion of gases, 2, 237–239
  - atomic,
    - heat, 7, 401
    - refraction, 2, 541
    - volume, 7, 401
    - weight, 1, 500–509; 2, 325, 541
  - bacteria, action on, 7, 86–92
  - catalysis, 2, 47, 233–239
  - copper thermocouple, 4, 219
  - density changes after gas occlusion, 2, 237–239
  - diffusion through, 7, 465–469
  - discovery, 2, 316–318
  - hydrogen in, density of, 5, 322
  - hydrogenated, physical properties, 2, 239
  - lead thermocouple, 4, 538
  - melting point, 5, 241
  - occlusion of hydrogen by, 2, 47, 233–239, 3, 190; 5, 212–213
  - platinum thermocouple, 5, 240–244
  - properties, 1, 352–353
  - resistance and temperature, 4, 524–527
  - silver alloy, 4, 231

**Palladium—cont.**

- specific heat, 2, 325
- square planar, 9, 503
- steel, in, 4, 158
- X-rays, 7, 451
- Young's modulus, 8, 354–355

**Palm leaves, silicon in, 7, 61****Palmitic**

- acid, 1, 479
  - film on water, 9, 40
  - formula, 1, 546–547
  - spreading on water, 10, 418–422
  - structure, 10, 448
  - surface pressure, 10, 420
- alcohol, 1, 546

**Panchromatic plates, 10, 131****Pansy, 10, 234****Papaverine, 7, 364–367****Paper,**

- burnt by infrared, 1, 532
- cigarette, 4, 359
- colouring by radium, 6, 49
- electrostatic screening, 4, 94
- fraction by shear, 8, 362
- manufacture, 9, 248
- phosphorescence, 1, 257, 309; 4, 373; 5, 464
- radioluminescence, 6, 41

**Para, Brazil, 2, 14–15****Para-azoxyanisole, 9, 536–544**

- transition points, 9, 536

**Para-azoxybenzoate, 9, 513–536**

- transition points, 9, 515, 536

**Para-azoxyphenetate, 7, 331; 9, 536–543**

- transition points, 9, 536

**Parabenzol, 1, 399****Parabolic mirrors, 4, 21****Paracyanogen, 2, 391–392****Paraffin, 2, 478–492**

- alcohols, relation to, 2, 482–486
- carbon, effect on, 8, 295
- colouring by radium, 6, 49
- coal, in, 1, 399
  - tar, 3, 361–362
- formulae, 2, 480
- inert to ozone, 2, 364
- infrared transmission, 8, 283
- isomers of, 2, 481–482
- melting points, 7, 133
- molecular refraction, 6, 156–182

**Paraffin—cont.****molecular refraction—cont.**

- volumes, 7, 133
- occurrence, 2, 479–480
- oxidised derivatives, 2, 487–489
- phosphorescence, 4, 377; 5, 464; 7, 81
- resistance and temperature, 4, 535; 5, 459
- specific heat, 6, 85–89
- structure, 6, 406–408
- synthesis, 2, 489–492
- viscosity, 5, 141–154
- wax,

- density, 6, 6
- expansion, 6, 6
- ionisation by radium, 5, 512
- refraction of Hertz waves, 4, 347
- structure, 6, 408

**X-ray diffraction, 9, 258****Parahydroxybenzaldehyde, 10, 118****Parahydroxybenzoic acid from peltandra, 10, 117**

- gonin, 10, 117
- structural formula, 10, 118

**Paraldehyde,**

- infrared absorption, 8, 286
- spectrum, 3, 215

**Parallel crystallisation, 7, 326–328****Parallelohedra, 7, 334****Paramagnetic,**

- elements, 3, 419
- salts, cooling, 10, 89–98
- thermometer, 10, 85–86

**Paramagnetism, 1, 69–73, 188–195; 5, 23–28; 9, 88–89**

- air, of, 1, 68
- cuprammine complex, of, 1, 68–69
- crystals, of, 1, 296
- definition, 2, 88–93
- ethylene, of, 1, 68
- gas, of, 4, 220
- iron,
  - carbonate, 1, 191
  - chloride, 1, 191
  - sulphate, 1, 191
- liquid oxygen, 5, 4–10
- nickel sulphate, 1, 79
- oxygen, 1, 68–69
- potassium ferrocyanide, 1, 191, 194
- temperature, effect of, 1, 195

- Parameters, crystallographic, 1, 294–304
- Parametral plane, 7, 350
- Pararosaniline, 6, 99–101
- Parasites, 2, 304–305
- Paratartaric acid, 1, 7–8
- Paraxylene, 5, 142–154
- Parchment, use in dialysis, 1, 395
- Parhelium, 8, 36, 372–373
- Partial,  
   molar volumes, 4, 4  
   pressures, Dalton's law, 2, 221  
   second, 8, 207
- Particles (*see also*  $\alpha$ -particles and  $\beta$ -particles)  
   atomic, 8, 244–252  
   light scattering, 2, 254–264; 9, 269–270  
   photography, 7, 312–324  
   size,  
     measurement, 7, 174–176  
     selection, 7, 174  
   subatomic, 5, 404–416
- $\alpha$ -Particles, 7, 312, 501–511  
   atomic structure, and, 8, 520–536  
   bombardment, 9, 495–496  
     of beryllium, 9, 414–418  
   charge-mass ratio, 7, 503  
   cloud chamber, in, 8, 521  
   collisions, 7, 316–318; 8, 244–252  
   counting, 8, 521  
   detection, 8, 521  
   dimensions, 9, 9–10  
   electric field, in, 8, 522–536  
   electron capture, 8, 522–536  
   energy, 8, 244; 9, 10–14  
   haloes, 8, 111–112  
   helium and, 3, 501; 9, 313–314  
   interaction with atoms, 8, 131  
   ionisation by, 8, 521  
   magnetic field in, 8, 522–536  
   nuclear fission by, 9, 13–16  
   nucleus, capture by, 9, 75–76  
   passage through mica, 8, 524–529  
   periodic table and, 8, 456  
   properties, 8, 520–536  
   radium, from, 8, 520–536  
   C, 8, 521  
   range, 9, 11  
   scattering, 8, 59, 244–252; 9, 73–76  
     aluminium, by, 9, 9–10
- $\alpha$ -Particles—*cont.*  
   scattering—*cont.*  
     gold, by, 9, 9–10  
     source, 9, 414–415  
     spectra, 9, 412–418  
     stability, 9, 8  
     tracks, 8, 521; 9, 187–188  
     velocity, 7, 312, 502–503  
       decrease, 8, 521  
       half-life, and, 8, 521  
       theory of, 8, 520
- $\beta$ -Particles, 7, 312, 501–511  
   electrons, and, 7, 501  
   periodic table, and, 8, 456  
   velocity, 7, 312, 503–504  
   X-rays, from, 7, 312
- Paroxyquinoline, 3, 372
- Parvoline, 1, 400
- Paschen series, 8, 34–46
- Paschen's radiation law, 5, 237–240
- Paste diamonds, 4, 487
- Patent law, 3, 173
- Path, mean-free, 7, 169–171
- Patterson projections, 10, 438–439
- Peacock's feathers, 5, 259
- Pear flavour, 1, 274
- Pectine, 10, 148
- Pectous colloids, 2, 216–217
- Pelargononin chloride, 10, 120
- Pelargonic acid, 1, 546–547
- Pelargonidin, 10, 114–127  
   chloride,  
     alkali fusion, 10, 114, 117  
     composition, 9, 115  
     formula, 9, 119  
   derivatives, 9, 115  
   iodide, 9, 121  
   structural formula, 10, 116–127  
   synthesis, 10, 121–127
- Pelargonin, 9, 115; 10, 112–127  
   chloride, 10, 115  
   fluorescence, 10, 120  
   glucose in, 10, 115–116  
   hydrolysis, 10, 115–116  
   scarlet, 10, 112–127  
   structural formula, 10, 116–127  
   synthesis, 10, 121–127
- Pelargonium,  
   petals, 9, 114  
   zonale, 9, 115, 10, 113
- Peltier effect, 1, 235; 2, 77; 3, 270–271

- Pettier effect**—*cont*  
 at absolute zero, 4, 258–259  
 discovery, 5, 60  
**Peltier's electroscope**, 1, 335  
**Pen**,  
   recorder, 1, 103–104  
   tantalum, 7, 50  
**Pendulum**, 1, 13–17, 121; 4, 354; 8,  
   199–205  
   beats, 8, 220–205  
   circular, 1, 16  
   coupled, 1, 387; 8, 200–205  
   driven, 8, 199–201  
   energy in, 1, 371–372  
   gyroscopic, 3, 292; 5, 187–188  
   impressed motion, 3, 1–2  
   isosynchronous, 2, 292–293  
   measurement of gravity, 4, 354  
   optical demonstration, 3, 13  
   phase, 8, 199–201  
   resonance, 8, 200–201  
     between two, 1, 387  
   Shortt, 10, 100  
   tuning, 8, 199–201  
**Penetrating radiation**, 9, 230–231  
**Penetration of  $\beta$ -rays**, 5, 414  
**Penicillium glaucum**, 6, 36  
**Pentacarbocyanines**, 10, 132, 138  
**Pentachloropyridine**, 8, 284  
**Pentadacylparatolyketone**, 4, 507  
**Pentamethyl glucose**, 9, 54  
**Pentane**, 2, 389  
   crystals, 4, 263  
   formula, 1, 545  
   infrared transmission, 8, 285  
   isomers, 2, 482, 486  
   nitrogen, and active, 7, 309  
   normal, 2, 482, 486  
   silicon, substitution, 2, 389  
   sound waves in, 9, 285–287  
   synthesis, 2, 489–492  
   viscosity, 5, 141–154  
**Pentanoic acids**, 2, 482  
**Pentene**, 2, 145  
   critical constants, 3, 315  
   formula, 2, 193  
   sound from radiation, 3, 152  
**Pentyl alcohol**, 2, 483, 486–487  
**Pentylamine**, 2, 145  
**Peonidin chloride**, 9, 120  
**Peonin**, 9, 120  
**Peony**, 9, 115, 120  
**Peppermint oil**,  
   action on photographic plate, 5, 259  
   extinction of phosphorous glow, 4,  
     15  
**Pepsin**, 10, 414, 422  
   molecular weight, 10, 416  
**Peptide bond**, 10, 218–219, 440  
**Peptone medium**, 7, 84  
**Peptous colloids**, 2, 216–217  
**Pepys and Faraday**, 2, 51–52  
**Perception of light**, 1, 241  
**Perchlorate ion**, structure, 9, 81  
**Perchlorates**, 1, 329, 332  
**Perchloric acid**, 1, 139, 328, 331–333  
   formula, 1, 454, 539–541  
   molecular structure, 1, 557  
**Perchromic acid**, 2, 182  
**Perfect gas**, 8, 347  
**Perforation of films**, 8, 435–436  
**Perfumes**, 6, 10–14  
   coal, from, 3, 372–376  
   enfleurage, 6, 11  
   history, 6, 10  
   refraction, 6, 165  
   solvent extraction, 6, 11  
   sources, 6, 11  
   steam distillation, 6, 11  
**Perfuming soap**, 3, 164  
**Period of water drop vibration**, 3, 331  
**Periodic**,  
   acid, 1, 333  
   classification of elements, 2, 326–  
     329, 501; 3, 404, 418–420  
   law, exceptions, 8, 132  
   table,  
     electrons, and, 8, 132  
     radioactive change, and, 8, 123–  
       124, 454–459  
      $\alpha$ -rays, and, 8, 456  
     X-rays, and, 7, 452  
     exceptions, 8, 132  
     gaps in, 7, 452  
**Perkin's green**, 2, 190  
**Permalloy**, 10, 462  
**Permanent magnetism**, 1, 69–73; 4,  
   127  
**Permanganate**,  
   ion, structure, 9, 81, 503  
   colour, 2, 182  
   kinetics of oxidation, 2, 134

- Permanganate—*cont.***  
spectra, 6, 99–100  
**Permanganic acid**, 1, 328, 333  
ozonic character, 1, 282  
spectrum, 6, 100  
**Permeability** (*see also Magnetism etc.*)  
definition, 4, 8  
iron, of, 4, 8  
liquid oxygen, of, 5, 4–10  
magnetic, 4, 430–431  
physical condition, and, 4, 10  
screening, and, 4, 96  
temperature, and, 4, 140; 5, 461–462, 542–545; 9, 443–445  
**Permittivity**, electric, discovery, 2, 78–82  
**Pernitrous acid**, 1, 95  
**Peroxidase**, 10, 338  
**Peroxide**,  
barium, 1, 94  
hydrogen, 1, 155  
kinetics of iodide oxidation, 2, 134–135  
manufacture, 6, 273  
ozonic character, 1, 282–283  
preparation from ozone, 1, 23  
**Perpetual motion**, 1, 180–187  
**Persistent radiator**, 4, 326  
**Persulphates**, 5, 498  
**Petals**, pelargonium, 9, 114  
**Petavel manometer**, 8, 463–465  
**Petavel's radiation law**, 5, 237–240  
**Petrification**, 10, 157  
**Petrol**,  
blow lamp temperature, 7, 237  
from coal, 9, 325–356  
**Petroleum**,  
benzene in, 9, 104  
Borneo, 9, 104  
ionisation by radium, 5, 512  
toluene in, 9, 104  
**Petrology**, 8, 111  
**Petunia**, 9, 115  
**Pewter**,  
action on photographic, 2, 258  
emissivity, 8, 290  
**pH**, 9, 320–322  
and sap colour, 9, 115  
indicators, 9, 321  
**Phaeophyceae**, 10, 235  
**Pharmaceutical products**, 9, 103  
**Phase**,  
diagram of,  
ice, 10, 380–383  
water-salt mixtures, 2, 525–526  
illumination, of, 6, 126–128  
pendulum, of, 8, 109–201  
rule, 9, 72  
vibration, of, 1, 247–248  
**Phellandrene**, 6, 12  
**Phenakite**, 1, 331  
in polariscope, 4, 187  
**Phenol**, 1, 274  
chemical properties, 1, 405–408  
coal, from, 1, 399  
depression of freezing point, 6, 97–98  
infrared transmission, 8, 286  
molecular structure, 1, 404  
phase diagram, 7, 22–28  
pressure effects, 7, 22–28  
reduction, 2, 245  
spectrum, 7, 359, 363  
sugar beet, from, 3, 31  
synthesis, 1, 271  
1 ton coal, from, 3, 365–366  
**Phenolphthalein**, 5, 529–530  
colour, 9, 21  
**Phenol**, dyes from, 3, 368  
**Phenyl**,  
azide, 7, 200  
infrared transmission, 8, 288  
blue, 1, 572  
ethyl ketone, 4, 378  
magnesium iodide, 9, 219  
radical, 1, 136, 403–404; 2, 186  
rosaniline, 2, 187  
thiocarbamide, 1, 271  
**Phenylcarbamic acid**, 1, 271  
**Phenylene**,  
diamine, 2, 187  
formula, 1, 543–544  
**Phenylglycine**, 5, 534  
**Phenylhydrazine**, 3, 370  
action of nitrous acid, 7, 200  
infrared transmission, 8, 287  
**Phlogiston**, 2, 282–291, 494  
**Phloral**, 1, 400  
**Phloroglucinol**, 9, 116  
pelargonin, from, 10, 117  
phosphorescence, 4, 377  
staining of wood, 10, 118  
structural formula, 10, 117–118



**Phloroglucinol—cont.**

synthesis, 10, 118

Phloxin, 3, 368

Phone, 3, 364, 368

Phonograph, photographic, 5, 501

Phonotrope, 8, 369

Phosgene, 4, 205; 7, 383

Phosijaw, 1, 38

**Phosphate,**

common of soda, 2, 207

ion structure, 9, 503

**Phosphates,**

formula, 2, 205

Graham's work, 2, 205–209

Phosphine, 1, 206, 209, 330–332

flame, 5, 31–32

formula, 1, 445–446, 455

Graham's work, 2, 208–209

impurities, 3, 23

infrared spectrum, 9, 226

molecular structure, 1, 402

smoke rings, 7, 439

spontaneous inflammability, 2, 208–209

vibrations, 9, 227–228

Phosphates, 10, 350

Phosphonium iodide, 1, 207

**Phosphor-bronze,**

bacteria, action on, 7, 86–92

bearing, 4, 433

eddy-currents in, 3, 306–311

low-temperature resistance, 4, 231

specific heat, 5, 192

Phosphorescence, 1, 86, 257–262, 309–313; 4, 507; 9, 26–31

apatite, of, 1, 309–310

barium sulphide, of, 1, 310–312

calcium sulphide, of, 1, 310–312

colours of, 1, 309–313

definition, 4, 375; 9, 26

detection of infrared by quenching, 9, 223

electrical, 1, 312, 472

fluorescence, and, 3, 253

demonstration of difference to, 4, 508

fluorspar, of, 1, 309–310

gems, of, 4, 491

hand, of, 1, 309

heat, and, 1, 309–310

intensity, 4, 375

**Phosphorescence—cont.**

model of, 3, 280–284

oxygen discharge, of, 1, 312

oyster-shell, of, 1, 309

ozone, and, 3, 472–475

paper, of, 1, 309

pressure, at low, 6, 225

strontium sulphide, of, 1, 310–312

spectra, 1, 309–313; 9, 451

Stoke's theory, 3, 245, 250–254

temperature, and, 4, 375–378

low, 5, 464; 7, 81

wavelengths of, 1, 309–313

**Phosphorescent,**

bacteria, 7, 83–92

bulbs, 4, 182

screen, 6, 233

**Phosphoric,**

acid, 1, 75, 206, 330–332

hydrated, 2, 207

glass, 9, 162

rate of discharge, on, 6, 21

Phosphoroscope, 1, 311

**Phosphorous, 1, 3**

abundance 10, 272

acid, 1, 93, 206, 330, 333

air, action of, 4, 14–15

allotropy, 1, 56–58, 134, 259, 470–473

amorphous, 1, 34–41

infrared absorption, 2, 5

animals, in, 9, 26

**atomic,**

heat, 7, 401

refraction, 2, 138, 541

volume, 7, 401

weight, 1, 500–508; 2, 541; 8, 340

Boyle's work, 4, 13–14

chemistry, 1, 206–213

chlorine flame, 2, 154–155

Dewar vessels, insulation in, 5, 164

diamagnetism, 1, 192

discovery, 2, 315–316; 9, 26

distillation, 4, 229

electrical discharge in, 1, 278, 470

flame, 5, 30

fluorine, action of, 5, 95

liquid, 6, 425

glass, in, 5, 445

glow, 1, 22; 4, 134, 375, 507; 9, 26–37, 218–219, 234–235

**Phosphorous—*cont.*****glow—*cont.***

- carbon dioxide, in, 5, 28–29
- mechanism, 4, 17; 9, 26
- oxygen pressure, and, 9, 27–37

**history, 4, 13****hydrides, 1, 138****infrared transmission, 8, 284****isotope, 8, 339–340****magnetism, 1, 145****magneto-optical properties, 4, 211****mass spectrum, 8, 339–340****matches, in, 1, 38****moist air, and, 1, 22****nuclear fission, 9, 13–16****occurrence, 9, 26****oxidation, 4, 375; 9, 218–219****by ozone, 1, 23****Graham's work, 2, 209****oxides, 4, 16–17****formulae, 2, 131****oxychloride, 1, 330; 2, 503****oxyfluoride, 5, 92****oxygen,****flame, 2, 152****liquid, reaction of, 4, 221; 5, 465****reaction, 7, 100****ozone,****reaction of, 3, 472****production, and, 1, 22****pentachloride, 1, 76; 5, 92****pentoxide, 2, 154****chemiluminescence, 5, 32****flames, in, 5, 31–32****occurrence, 2, 500****thermoluminescence, 5, 32****production of gold films by, 1, 216, 249–251****protoplasm, in, 7, 61****radium,****effect of, 5, 512****reaction of, 6, 49****rickets, and, 8, 375****solar, 1, 257****solution, in, 5, 195****specific gravity, 1, 38****steel, in, 1, 513****surface tension of liquid, 4, 118****toxicity, 1, 38****trichloride, 1, 330, 374****hydrolysis, 1, 452****Phosphorous—*cont.*****trifluoride, 5, 92****trioxide, 4, 16–17****valency, 3, 545; 8, 328****volatilisation, 4, 15–16****X-ray absorption, 5, 160****Photo-etching, 4, 41–42****Photobacterium phosphorens, 7, 84–92****Photobromide, 4, 47****Photocell, 7, 82–83****chlorine dioxide, 7, 82–83****construction, 3, 139–142****performance, 3, 142****selenium, 2, 468–471; 3, 134–147****silver-silver chloride, 7, 82****uranium nitrate, 7, 82–83****Photochemical,****kinetics, 10, 398–402****oxidation, 1, 24****polymerisation, 10, 401–402****sensitisation, 9, 220****sun, action of, 1, 456–462****Photochemistry, 1, 202–204, 256–262, 319–326****at low temperatures, 7, 80–92****heat insulation, 7, 80****studied by Rumford, 2, 275****Photochloride, 4, 45–47****Photoconduction, 2, 466–477****discovery, 3, 139****selenium, of, 2, 468–477; 3, 138–149****Photoelectric,****detectors, 4, 336****effect, 3, 8–10; 5, 407; 9, 182–192, 201****chlorides, of, 5, 37****quantum theory, 8, 109, 516; 9, 182–192****temperature, and, 9, 431–432****X-ray, 6, 170****Photogenic bacteria, 7, 84–92****Photographic,****actinometer, 1, 459–462****detection of,****infrared, 3, 207** **$\alpha$ -particles, 8, 521****emulsions, 10, 140****hydrogen peroxide, action of, 5, 260–263****lenses, 5, 452****paper, 1, 459–460**

**Photographic—cont.**

phonograph, 5, 503

plate, 4, 333

radiation detector, 4, 341

radium, action of, 6, 49

radioactivity, action of, 4, 502; 5, 508–524

shearing stress, effect of, 4, 48

spectra, 1, 431–434

sun,

effect over disc, 1, 461–462

measurement of intensity, 2, 13–21

X-rays, intensity of, 5, 122

**Photographs,**

Jupiter, of, 1, 260

moon, of, 1, 260

projection of, 1, 260; 4, 183

**Photography, 1, 202, 257, 259, 427–434, 439–449; 2, 467**

air, 10, 137

altitude, at, 2, 13–21

applications, 4, 58–71

at  $-200^{\circ}\text{C}$ , 4, 232

bubbles, of, 4, 61

colour, 4, 478–484

sensitivity, 4, 44

cyanine dyes in, 10, 129–141

discovery, 4, 39–40

of colour, 4, 479

drops, of, 10, 8–14

electric, 4, 494–495

elementary particles, of, 7, 312–324

explosions, of, 9, 465–494

flame velocity, and, 4, 143

flames, of, 9, 465–494

glucose in, 4, 48

grain of, 8, 237

high-speed, 10, 11–14

history, 4, 39–42

hyposphites in, 4, 48

indoor, 10, 134

inductoscript, 4, 495

infrared, 3, 207; 7, 205–222; 9, 223

sensitisers, 10, 135–141

interference bands, of, 4, 242–243

interferential colour, 4, 480–484

isocyanine dyes in, 10, 130–141

liquid hydrogen temperature, at, 6, 424

lactose in, 4, 48

long-distance, 10, 137

**Photography—cont.**

mercuric chloride effect, 4, 434

moon, ultraviolet, of, 7, 214–217

nebulae, of, 8, 312

Newton's rings, of, 3, 62; 4, 42

pin-hole, 4, 70

of anticathode, 5, 120–122

potassium dichromate effect, 4, 44

radioactivity, of, 7, 312–324

reversal, 8, 111

revolving cylinder, 4, 143

scattered light, of, 8, 312–313

sensitising dyes, 10, 128–141

shock waves, of, 5, 326

silver nitrate effect, 4, 44

soap films, of, 4, 64

sodium sulphate effect, 4, 44

solar spectrum, of, 10, 138

spark in, use of, 4, 61–71

spectral intensity, and, 8, 236–238

spectroscopic, 1, 427–434

splashes, of, 4, 291–320

temperatures, low, at, 4, 378–380; 5, 167–169, 465

theory, 4, 44–48

of colour, 5, 124–134

three-colour method, 4, 479

ultraviolet, 7, 205–222

vanadium, using, 2, 505

water-jets, of, 4, 61–64

X-rays, 4, 485, 510

diffraction, of, 7, 340–341

**Photoluminescence, 4, 507****Photolysis,**

chlorine dioxide, of, 7, 80

ferrous carbonate, 9, 195

iron oxalate, 1, 261

**Photometer, 8, 363–369**

chemical, 1, 319–326

electrical, 3, 8–10

hydrogen-chlorine, 1, 457–459

liquid-phase, 3, 8–10

photographic, 1, 459–462

Rumford, studied by, 2, 275

selenium, 2, 468–477

**Photomicrography, 6, 130****Photon-electron collision, 9, 5****Photophone, 3, 138–149**

selenium, 3, 209

**Photosalt, 4, 45–47**

- Photosynthesis, 1, 257, 375, 456-462;  
2, 165, 467; 5, 372; 9,  
193-200  
artificial, 9, 195-200  
chloroacetic acid, of, 1, 270  
formaldehyde, of, 9, 194  
heat of, 9, 194  
ultraviolet light in, 9, 194  
vitamin A in, 8, 375  
Phthaleines, 5, 529  
Phthalic,  
acid from naphthalene, 6, 413  
manufacture, 5, 534-535; 9, 103  
anhydride, 4, 377  
Phthalocyanines, 10, 224-225  
Phylloxera vastratrix, 4, 186  
Physalien, 10, 231  
Physical properties and chemical con-  
stitution, 2, 177-182  
Physics, molecular, 1, 492-499; 3, 38-  
59; 8, 100-110  
and spectroscopy, 3, 122  
Physiological chemistry, 8, 26-31  
effect and chemical constitution of,  
2, 177-183  
alkaloids, 2, 182  
antipyrene, 3, 371  
carotenoids, 10, 237  
electricity, 1, 366-369; 4, 169  
heavy water, 10, 20  
hydrazoic acid, 7, 197  
hydrogen fluoride, 5, 88  
kairine, 3, 370  
nickel carbonyl, 4, 209  
oscillating voltage, 4, 334  
pyridine salts, 3, 370  
quinine, 3, 369-370  
radium, 6, 49  
saccharine, 3, 375-376  
temperature, 5, 470-472  
thalline, 3, 371-372  
ultraviolet light, 7, 488  
vanadium, 2, 503-504  
optics, 4, 384  
radiation detectors, 4, 341  
work, 1, 417-421  
Phytol, 10, 237  
Piano, 3, 1; 8, 211  
steel-lead thermocouple, 4, 538  
Picariae, 4, 237  
Pickering series, 8, 39-40  
Picoline,  
coal, from, 1, 400  
glass, 4, 263  
infrared transmission, 8, 288  
Picrates, 10, 122  
Picric acid, 1, 274; 3, 368; 7, 201; 9,  
103; 10, 122  
Picryl,  
chloride, 7, 201  
triamine, 1, 543-544  
Pictet's apparatus, 4, 457  
Piezoelectric effect, 9, 283; 10, 172-177  
Piezometer, 7, 20  
Pig, 10, 235  
Pigment, 9, 18  
animal, 4, 235-240  
anthocyanin, 9, 114-121  
black grapes, in, 9, 115  
crystallinity, 9, 114  
epiphasic, 10, 231  
fatty, 10, 227-243  
feathers, from, 4, 236-240  
form in plants, 9, 114  
geranium, 9, 114  
hypophasic, 10, 231  
insects, in, 9, 261  
natural, 9, 114-121  
plastid, 9, 114; 10, 227-243  
Pile, Rittarian, 5, 484-485  
Pin-hole camera, 4, 70  
photography of anticathode, 5, 120-  
122  
Pinachrome, 10, 130  
Pinacyanol, 10, 130, 135-136  
ethiodide, 10, 131  
structure, 10, 131-133  
Pinakoidal faces, 7, 350  
Pinaverdol, 10, 130  
Pinch effect, 1, 30; 7, 374-377  
Pineapple, 5, 23  
flavour, 1, 274  
Pinene, 6, 12  
film, 8, 1  
nitroschloride, 7, 202  
spectrum, 7, 358  
Pink cornflowers, 10, 112-127  
Pipe, churchwarden, 7, 240  
Piperidine,  
action of phosgene, 7, 383  
catalysis of mutarotation, 7, 383  
Piperonic acid, 6, 13

- Pistons**, 10, 251
- Pit shafts**, 8, 292-294
- Pitch**,  
   coal, from, 9, 336-340  
   flow, 10, 7  
   liquid, 6, 67  
   motion, effect of, 4, 196  
   microwave absorption, 5, 17  
   polishing, use in, 5, 395  
   viscosity, 6, 67-73
- Pitchblende**, 6, 52
- Joachimstahl, 5, 512
- lead from, 8, 126, 134
- radium G in, 6, 278
- thorium-uranium ratio, 8, 128
- uranium-ionium ratio, 8, 128
- Pith-ball**, 4, 94
- Pitting of glass**, 5, 393
- Plagiedral facettes of quartz**, 1, 7
- Planaria**, 9, 293
- Planck's**,  
   constant, 7, 508-509  
   radiation law, 8, 106, 276
- Plane**,  
   basal, 7, 350-351  
   black films, 8, 136-142  
   crystal, 7, 343  
   dispersion, crossed axial, 5, 548  
   force, of, 8, 503-506  
   Grandjean's, 9, 546  
   parametral, 7, 350  
   polarisation, 2, 271-272  
   polarisation, of, 8, 348
- Planetary**,  
   distances, 8, 224-226  
   nebulae, 8, 242
- Planets**,  
   heating of, 1, 307-308  
   infrared emission, 9, 227  
   motion of, 4, 350; 5, 296  
   orbits, of, 8, 102, 190-191  
   sun, chemical action of, 1, 324  
   temperature, 9, 227
- Plant**,  
   carbon dioxide absorption, rate of, 8, 375  
   growth, 1, 303  
   heavy water, effect of, 10, 20  
   nutrition, 5, 372  
   photosynthesis, 9, 193-200  
   pigments, 4, 235
- Plant—cont.**  
   pigments—*cont.*  
     fatty, in, 10, 227-240  
     form of, 9, 114  
     response to stimuli, 5, 423-424  
     silicon in, 7, 60-63  
     transpiration of water, 5, 372-373  
     ultrasonics, effect of, 9, 292-296  
     water, loss of, 2, 402
- Plantain**, 5, 23
- eater, 4, 236-240
- Plasma chemistry**, 3, 80-90
- Plasmolysis**, 5, 391
- Plastic**,  
   deformation, 8, 292  
   sulphur, 1, 135
- Plasticity**, 8, 361-362
- ice, of, 10, 359-373
- minerals, of, 10, 155
- Plastid pigments**, 9, 114; 10, 227-240
- Plate**,  
   colours of, 3, 438-439  
   cyanin-sensitised, 4, 242  
   grain of, 8, 237  
   Lummer-Gehrcke, 8, 239  
   orthochromatic, 10, 129  
   panchromatic, 10, 131  
   quarter-wave, 2, 357  
   reflection by multiple, 8, 282  
   Schumann, 8, 523  
   vibrations, 9, 298-304
- Plateau's soap solution**, 8, 1
- Platinic chloride**, 2, 248
- Platiniferous metals**, 1, 352-353
- Platinocyanides**,  
   fluorescence, 1, 487; 4, 507  
   low temperature phenomena, 5, 465  
   phosphorescence, 4, 377-378  
   radioluminescence, 6, 41, 509-510  
   X-ray fluorescence, 4, 485-486, 507
- Platinoid**,  
   lead thermocouple, 4, 538  
   low temperature resistance, 4, 231  
   resistance and temperature, 4, 525-527
- Platinotype**, 4, 42
- Platinous chloride**, 2, 248
- Platinum**, 1, 352-353  
   alloy with lead, 1, 353  
   aluminium couple, 2, 497  
   ammonia compounds, 2, 246-253

**Platinum—*cont***

- ammonium chloride, 1, 353
- colour and temperature, 4, 267, 5, 464, 6, 428
- anticathode, 5, 112
- atomic,
  - heat, 5, 190–194, 7, 401
  - radius, 9, 502
  - refraction, 2, 541
  - volume, 7, 401
  - weight, 1, 500–508, 2, 325, 541, 5, 190
- bacteria, action on, 7, 86–92
- carbon disulphide, action on, 7, 152
- catalysis, 1, 160–163, 7, 100–101, 9, 339
  - combustion, 7, 405–406
  - deuterium substitution 10, 63–64
  - hydrogen peroxide decomposition, 8, 27
  - oxygen hydrogen reaction, 2, 72, 8, 28
- cathode, 6, 243
- chemical properties, 2, 248–253
- cleaning of surface, 8, 28
- contact electricity, 5, 56, 82, 83
- copper thermocouple, 4, 219
- crystal structure, 9, 210
- deuterium bombardment, 10, 252
- diffusion,
  - hydrogen through, 2, 39–45, 233–239
  - through at high temperatures, 7, 465–469
- discovery, 2, 315–316
- electrodeposition, 1, 259
- electrodes, 3, 107–108, 7, 403
- electron diffraction, 9, 208–210, 362
- expansion thermometer, 5, 240–243
- filament, 7, 47
- fluoride 5, 90–93
- fluorine preparation, attacked in, 5, 88
- gas oxidation on, 6, 300
- heat of electron emission, 7, 496
- hydrogenation catalyst, 10, 63–64
- iridium,
  - alloy,
    - resistance, 4, 525–527
    - at low temperature, 4, 231
- kilogramme, 10, 15

**Platinum—*cont***

- isomerism of compounds, 5, 195–196
- isotopes, 10, 252–253
- lead thermocouple, 4, 537–538
- Kolbe electrode, 8, 345
- magnesium couple, 2, 497–498
- magneto-optical properties, 5, 175
- melting,
  - cathode rays, by, 4, 491
  - point, 5, 241, 7, 237
- metal oxide cathode, 7, 36–37
- occlusion of hydrogen by, 2, 45–46, 233–239
- palladium thermocouple 5, 240–241
- physical properties, 2, 248
- potassium chloride, 5, 491
- preparation, 5, 194
- proton bombardment, 10, 252
- purification, 5, 194
- radiation from hot, 1, 46
- rate of discharge, 6, 21
- resistance and temperature, 4, 522, 527
  - liquid helium, in, 7, 234
  - low temperature, at 4, 230
  - thermometer, 2, 342–352, 4, 522–524, 537, 5, 208–217, 240–247
  - limits, 7, 238
- rhodium alloy,
  - resistance, 4, 525–527
  - at low temperature, 4, 231
  - thermometer, 5, 212
  - thermocouple, 5, 240–241
- silver alloy, resistance, 4, 525–527
- at low temperature, 4, 231
- specific heat, 2, 325, 5, 190–194
- thermometer, 5, 240–241
- square planar, 9, 503
- steel, 9, 97
- surface tension of liquid, 4, 118
- temperature scale, 4, 522–524
- thermionic emission, 7, 492–500
- thin film, 3, 239
- vessels, 5, 88–89
- wire,
  - exploding, 3, 98
  - furnace, 7, 239
  - thin, 3, 563
- X-ray,
  - formation of, 4, 504

**Platinum—cont.****X-ray—cont.**

target, 8, 50

Young's modulus, 8, 354–355

**zinc,**

couple, 2, 497

thermocouple, 4, 540

**Pleochroic haloes, 8, 128****Pleurosigma formosum, 1, 123****Plucked strings, 8, 207****Plumage (see Feathers)****Plumb-line, 4, 351**measurement of gravity, 4, 354; 5,  
297–298**Plumbago, 3, 218****Plumbous ion, 9, 86****Plutonium discovery, 10, 254–255****Pneumatic electricity, 1, 111****Pneumococcus, 9, 275** **$\lambda$ -Point, 10, 463–474**

critical, 3, 24–27

groups, 7, 122–134, 333

ignition, 6, 299

representative, 7, 330

systems, 7, 333

**Poisoning of surfaces, 9, 2****Poisons,**

detection, 7, 368

stimulants, as, 5, 436

**Poisson's,**

ratio, 4, 371

definition, 8, 351

measurement, 8, 352

theory of magnetism, 4, 128

**Polarimeter, 3, 527****Polarisability, molecular, 6, 153–166****Polarisation,**

apparatus, 5, 20

axis, 1, 299

birefringence, by, 5, 544

circular, 2, 271–272

colours, 3, 516

degree of, 8, 312–313

electric, 1, 266–269

ray, of, 5, 11–26

electrodes, of, 5, 484

elliptical, 2, 271–272

gas discharge, in, 1, 31

heat, of, 1, 45–47

Hertz waves, of, 4, 348

indigo films, by, 3, 535

**Polarisation—cont.**

infrared, of, 1, 45–47; 2, 331

by crystals, 1, 297

light, of, 1, 4–8; 2, 168–177, 271–  
274, 331absorbing substances, by, 1, 487–  
488

clouds, by, 2, 169

crystals, by, 1, 298–304

discovery, 2, 168

gold-leaf, by, 1, 250–251

model, 3, 518–522

potassium permanganate, of, 1,  
487–488scattering, of, 2, 172–177, 261; 3,  
348–349; 7, 97; 8, 308–  
309; 9, 271–280

sky, from, 7, 97; 8, 309

theory, 2, 272–274

tourmaline, of, 2, 168–169

magnetic field, and, 4, 21–22

metals, of, 9, 444

microwaves, of, 5, 20–25

night sky, of, 8, 313–314

plane, 2, 271–272

rays, of, 4, 502

reflection, by, 2, 271–272

scattered light, of, 2, 172–177, 261;  
3, 348–349; 7, 97; 8, 308–  
309; 9, 271–280

X-rays, of, 4, 488, 509; 7, 446

by scattering, 8, 60

Zeeman lines, of, 5, 268

**Polariscope, 7, 325; 4, 183–188**

Savart, 8, 313–314

tourmaline, 2, 271–274

**Polarised light, 1, 270; 2, 84–88, 393–  
397; 5, 170–188**

applications, 7, 371–384

astronomy, in, 2, 393

circular, 2, 357–361

colour, and, 2, 405–410

crystals, and, 1, 256

rotation, 1, 141–142

magnetic field, by, 1, 81–82 (*see*  
*also Faraday effect*)

quartz, by, 2, 271–274

**Polariser, 2, 271, 357–361; 3, 519–524**

glass-fibre, 4, 24

microwave, 5, 20–22

model, 3, 519–522

**Polariser—cont.**

- wire-grid, 4, 348; 5, 20–22
- Polarising microscope, 7, 325
- Polaristorbometer, 3, 529
- Polarity, chemical in sparks, 1, 111
- Poles, conical, 1, 2–3
- Polishing of surfaces, 10, 208–211,  
247–248
  - optical, 5, 392–403
  - temperature, 10, 250
- Pollen, 2, 302–303
- Polluted air, 2, 302–313
  - infrared absorption, 1, 424–425
- Pollux, 1, 509
- Polonium,
  - chemical properties, 8, 120
  - discovery, 5, 512; 6, 40
  - half-life, 6, 278
  - isolation, 6, 282
  - isotopes, 8, 457
  - periodic table, in, 8, 120
  - radioactivity, 5, 512–524
  - radium A, and, 8, 122
  - source, 9, 414–418
- Polyatomic gases, 5, 337–338
- Polybasic compounds, 2, 207
- Polyglucosan, 9, 60–61
- Polygonum tinctoria, 3, 161
- Polymerisation, 10, 257–269
  - carbon monosulphide, of, 7, 145–153
  - condensation, 10, 268–269
  - ethylene derivatives, of, 10, 260–268
  - glucosan, of, 9, 60
  - initiation, 10, 261–262
  - kinetics, 10, 262–263
  - mechanism, 10, 261–269
  - methyl methacrylate, of, 10, 401–402
  - styrene, of, 1, 56
  - photochemical, 10, 401–402
  - propagation, 10, 263–264
  - termination, 10, 265–268
- Polymers of olefines, 2, 193
- Polypeptide chains, 10, 416
  - synthesis, 7, 200
- Polysaccharides, 9, 50, 58–62
  - hydrolysis, 9, 50–51
  - synthesis, 9, 60–67
- Polystyrene, 1, 56
- Poppy, 9, 115
- Porcelain, 9, 109
  - combustion catalysis, 7, 406

**Porcelain—cont.**

- pyrometer, 5, 244–247
- Porosity of charcoal, 6, 107–108
- Porous plus, 5, 363
  - experiment, 6, 356
- Porphyrised copper, 4, 336
- Port wine, 1, 484
- Portable detector, 4, 343
- Positive,
  - electricity, 6, 232–247, 314; 8, 118–119
    - electron (*see Positron*)
  - glow, passage down tube, 4, 283
  - ions, 5, 408; 6, 232–247, 314–344
    - effect of fields, 6, 235–247
    - emission from hot bodies, 7, 492–500
  - rays, 6, 232–247, 314–344
    - applications, 7, 294–305
    - pressure, 5, 105
- Positron, 9, 499; 10, 37–38, 253
- Potash,
  - electrolysis, 6, 267–269
  - glass, 9, 157
    - X-ray absorption, 4, 487
- Potassamide, 1, 448
- Potassium,
  - abundance, 10, 272
  - acetate, 8, 344
  - alum, 1, 536
    - density, 6, 6
    - expansion, 6, 6
    - specific heat, 6, 85–87
  - aluminium silicate, 1, 536
  - amalgam, 1, 271, 477
  - atomic,
    - heat, 7, 401
    - radius, 8, 326
    - refraction, 2, 541
    - spectrum, 1, 354–359, 433; 3, 71–79
    - volume, 7, 401
    - weight, 1, 500–508; 2, 325, 541
  - bisulphate, 1, 329
  - borofluoride, 7, 337
  - bromide,
    - fixer, 4, 480
    - ultraviolet absorption, 1, 430–431
  - water,
    - eutectic, 2, 522
    - phase diagram, 2, 523



**Potassium—cont.**

- cadmium iodide, 5, 491
- carbon dioxide absorption spectrum, 3, 71–72
- carbonate,
  - production, 3, 30
  - solid-phase reactions, 3, 541
- carbonyl, 4, 206–207
  - action of water, 4, 214
- chlorate, 1, 454; 4, 457
  - colour, 7, 448
  - decomposition, 1, 159, 161
  - iridescence, 3, 493–495
  - seeding by, 3, 399
  - water eutectic, 2, 522
- chloride, 1, 211; 9, 71
  - crystal structure, 7, 449–450; 8, 319, 321–322, 327–328
  - electrolysis, 2, 246; 5, 488
  - fluorine, action of, 5, 96
  - media, in, 7, 84
  - seeding by, 3, 399
  - solution conductivity, 6, 95
  - water eutectic, 2, 522
- chromate, 1, 129, 220–221
  - absorption spectrum, 1, 223, 484
  - crystals, 7, 327–328
  - gelatin, in, 4, 42
  - optical properties, 1, 301
  - water eutectic, 2, 522
- chromium alum, 10, 93
- colour test for, 1, 354–355
- croconate, 4, 214
- crystal structure, 8, 330
- cyanate, 1, 476; 4, 124
- cyanide,
  - fixer, 4, 480
  - molar refraction, 2, 138
  - thinning of gold-leaf by, 1, 216
- cyanin, 9, 114
- density, 6, 269–270
- dichromate,
  - colour and temperature, 4, 261
  - crystallisation, 7, 327
  - oxidation of aniline, 1, 407
  - photography, effect in, 4, 44
  - transformation under pressure, 7, 21
  - water eutectic, 2, 522
- discovery, 2, 315–317; 6, 267–269
- electrodes, 7, 403

**Potassium—cont.**

- electron diffraction, 9, 191
- electronic structure, 8, 327
- ethyl sulphate, 1, 329
- ethylate, 1, 451
- ferric silicate, 9, 161
- ferricyanide,
  - density, 6, 6
  - expansion, 6, 6
  - photoelectric effect, 3, 10
- ferrocyanide,
  - density, 6, 6
  - expansion, 6, 6
  - magnetic properties, 1, 191, 194, 221
  - optical activity under compression, 4, 124
  - photoelectric effect, 3, 10
- fluorine, action of, 5, 96
  - liquid, 6, 425
- formate, 1, 479
- glass, in, 5, 445
- gold chloride, 5, 491
- hydride, 3, 190
- hydrogen sulphate, 1, 329
  - electrolysis, 5, 498
- hydroxide, 1, 451
  - alcoholic, 1, 575
  - diamond, effect of fused on, 7, 33
  - nerve response, effect on, 5, 438
  - reaction with carbon monosulphide, 7, 152
  - solution, liquid air on, 6, 211
- iodide,
  - supersaturation, 3, 400
  - test for ozone, 2, 363
  - ultraviolet absorption, 1, 430–431
  - water,
    - eutectic, 2, 522
    - phase diagram, 2, 523
- iodine chemiluminescence, 9, 220–221
- ion,
  - electronic structure, 8, 327
  - radius, 9, 86
- laurate, 9, 65–72
- lithium sulphate, 9, 85–87
- magnesium,
  - selenate, 5, 544
  - spectrum, 3, 189
  - sulphate, 3, 398
- metallic character, 6, 270

**Potassium—*cont.***

- nickel sulphate, 1, 329
  - crystal structure, 7, 351
- nitrate, 1, 221, 454
  - Bath springs, in, 5, 158
  - conduction by solid, 1, 166
  - diamagnetism, 1, 192
  - electrolysis, 5, 486
  - solid-phase reactions, 3, 541
  - ultraviolet absorption, 1, 430–431
- water,
  - eutectic, 2, 522
  - phase diagram, 2, 523
- nuclear fission, 9, 15–16
- oleate, 8, 17–19, 388, 448
- oxide, 1, 211
- oxygen, action of, liquid, 4, 221; 5, 465
- ozone, action of, 3, 472
- perchlorate, 1, 329, 332
  - crystals, 7, 327–328
  - isomorphism, 7, 337
- permanganate, 1, 221, 454, 551
  - charcoal, action on, 6, 231
  - hydrogenised palladium, reduction by, 2, 47, 233–239
  - isomorphism, 7, 337
  - reflection by, 1, 487–488
  - spectrum, 6, 100
- peroxide, 1, 282
- platinochloride, 5, 491
- platinocyanide, 4, 510
- preservation, 6, 269
- production, 1, 285
- properties, 6, 269
- selenate, 7, 327–328
  - crystal structure, 5, 359
- silver cyanide, 5, 491
- soaps, 8, 17–18
- sodium,
  - alloy, 6, 269
  - cathode, 6, 243
  - tartrate, 1, 299
- specific heat, 2, 325
- steel, in, 1, 513
- sulphate, 1, 211; 3, 551
  - Bath springs, in, 5, 158
  - crystal, 7, 327–328
  - structure, 5, 539; 7, 337
- depression of freezing point, 6, 97–98

**Potassium—*cont.***

- sulphate—*cont.*
    - optical properties, 1, 301
    - water eutectic, 2, 522
  - sulphindigotate, 1, 220
    - absorption spectrum, 1, 223
  - sulphocyanide, 1, 128
  - sun, in, 1, 358, 433, 510
  - surface tension of liquid, 4, 118
  - tantalum,
    - fluoride, 7, 48
    - production, in, 7, 48
  - tartrate, spectrum of charred, 3, 71
  - thiocyanate, 1, 128
    - molar refraction, 2, 138
  - trace in explosion, 3, 445–450
  - ultraviolet spectrum, 3, 259, 262, 266
  - uranium sulphate, 5, 508–524
  - X-ray,
    - absorption, 5, 160
    - scattering factor, 7, 452
  - zinc sulphate, 5, 540
    - hydrate, 2, 210
    - zincate, 1, 155
- Potato, 2, 276
- Potency of vitamins, 8, 374–375
- Potential,
  - chemical, 8, 29
  - electrical, 1, 366–369
  - energy, 1, 198–199; 5, 277
  - gradient in flames, 7, 2
  - surface, 10, 395
  - thermoelectric, 4, 431
- Potentiometer, 4, 536
- Pots, membranes in, 7, 5
- Pottery, zirconia, 7, 241
- Pound force, 4, 428
- Powder method of X-ray diffraction, 8, 318–390
- Powders,
  - absorption by, 5, 253
  - in liquids, 3, 479
  - insulation by, 7, 228–230
- Power,
  - absolute refractive, 6, 154
  - gas explosions, from, 4, 142
  - magnifying, 6, 128–130
  - Niagara Falls, from, 6, 375
  - transmission, 6, 375–376
- Poynting's measurement of G, 5, 301–303

- Praesodymium**, 3, 415  
**Precession**, 1, 115-121  
     of equinoxes, 1, 119-120  
**Precessional spin**, 5, 274  
**Precipitation**,  
     rate, 8, 26  
     salts, of, 6, 101  
     sulphides, of, 5, 498  
**Prediction**,  
     isotopes, of, 3, 421  
     Thompson effect of, 6, 354  
**Preferential hydrogen combustion**, 6,  
     301-313  
**Presspahn**, 8, 299-300  
**Pressure**,  
     allotropy, and, 7, 23; 8, 294  
     apparatus for high, 7, 29-32  
     arc length, 3, 98-99  
     around moving ball, 7, 104  
     atmosphere and height, of, 3, 105-  
         106  
     boiling point, 2, 182  
     candle, effect on light intensity from,  
         1, 360-364  
     column, mercury, 5, 452  
     combustion, and, 1, 360-364; 8,  
         462-488  
     comparison of vapour, 4, 472  
     cordite explosion, in, 7, 29  
     critical, 2, 294-301; 3, 314-317  
     Dalton's law of partial, 2, 221  
     difference measurement, 7, 12  
     discovery of radiation, 6, 150  
     earth's centre, at, 8, 348  
     electric discharges, changes in, 3,  
         110-111  
     electrolysis, from, 2, 294-301  
     explosion, 3, 449-450; 9, 466-467  
         at high, 6, 312  
     flows, changes in, 7, 432-436  
     gas, of, 8, 347  
     gauges, 5, 451  
     granite, effect on, 8, 291-292  
     guns, in, 8, 296  
     high, 2, 294-301; 7, 16-35; 8, 291-  
         308 (*see also High pressure*)  
     ice, effect on, 8, 294  
     infrared absorption, and, 1, 349  
     ion, 3, 41-59  
         velocity and, 8, 179-180  
     *Pressure—cont.*  
         light, 2, 2, 442-465; 6, 419; 8, 192,  
             514-515  
             explanation of Crookes' experi-  
                 ment, 3, 40  
             measurement, 8, 463-465  
             limestone, effect on, 8, 291-292  
             by radiometer, 6, 417  
             of low, 6, 260-261  
         melting point, and, 7, 17  
         negative, 4, 111  
         occlusion, 6, 254-255  
         osmotic, 6, 96; 7, 5-15  
         oxygen and phosphorous glow, of,  
             9, 27-37  
         radiation, 2, 9, 442-465; 6, 150-152,  
             419; 8, 192, 514-515  
             and relativity, 8, 515  
         soap bubbles, in, 1, 131  
         sound, of, 9, 288-289  
         spectra, and, 8, 242  
         sun's centre, at, 8, 348  
         surface, 10, 240  
         time recorder, 8, 466-467  
         vapour, 2, 462  
             colloids, of, 9, 64-67  
             soap solutions, of, 9, 64-67  
         viscosity, and, 5, 143-144  
         water, effect of freezing of, 1, 181  
         wind, 5, 448-450  
**Pressurised bomb**, 6, 312  
**Prince Rupert's drop**, 4, 187  
**Principal series**, 8, 35-36, 239  
**Principle**,  
     action, of, 9, 206  
     Carnot's, 6, 348-360  
     Fermat's, 9, 206  
     interference, of, 3, 269  
     Korner's, 10, 117  
     least action, of, 5, 565  
     reciprocity, of, 6, 59-60  
     relativity, of, 8, 100-110, 181-197,  
         214; 10, 301-333  
     similarity, of, 7, 440-444  
     uncertainty, 9, 365-385  
         and isotope effects, 10, 49-57  
     Venturi, 7, 432-436  
**Primary**  
     colours, 1, 241-245; 3, 438  
         spectra of, 5, 126-127  
     faces, 7, 334

- Primula, 9, 116  
 Printing, 3, 169  
 Prism,  
   calcite, 8, 316  
   fluorite, 9, 225  
   home-made, 5, 392  
   Nicol, 2, 109, 357, 394; 5, 543  
   optical, 1, 221  
   quartz, 8, 316; 9, 225  
   rock-salt, 1, 530; 9, 223, 225  
   sylvin, 9, 225  
 Prismatic faces, 7, 350  
 Proactinium, 8, 457  
 Probability distribution of velocities,  
   8, 239  
 Probosis of blowfly, 4, 186  
 Process, irreversible, 4, 141  
 Producer gas, 7, 417  
 Production of metals by displacement,  
   1, 285  
 Projectiles, 1, 117-118  
 Projection,  
   microscope, 4, 183-188  
     demonstration, 4, 186  
     resolution, 4, 184  
   objective, 4, 185  
   optical, 4, 183-188  
   Patterson, 10, 438-439  
   photographs, of, 1, 260  
   slides, of, 4, 187  
   spectra, of, 4, 183-188  
 Prolectite, 7, 130-133  
 Propaldehyde, 8, 286  
   structure, 2, 199  
 Propane, 1, 273  
   formula, 1, 545; 2, 199  
   molecular structure, 1, 560-562  
   preparation, pure, 2, 498  
   synthesis, 2, 498  
 Propellor, 7, 431  
 Propene, 2, 193  
 Propiolic acid, 3, 167-173  
 Propionaldehyde, 2, 194  
 Propionic acid, 1, 479  
   formula, 1, 546-547  
   infrared transmission, 8, 287-288  
   silicon-substituted, 2, 388  
   synthesis, 2, 146, 273  
   viscosity, 5, 142-154  
 Propagation,  
   polymerisation, of, 10, 263-264  
 Propagation—*cont.*  
   rate of explosion, 3, 440  
 Proportions, multiple, 6, 90  
 Propyl,  
   acetate, 4, 142-154  
   alcohol, 1, 479; 2, 388  
     depression of freezing point, 6,  
       97-98  
   formula, 1, 546  
   infrared transmission, 8, 286  
   isomers, 2, 485  
   normal, 2, 483, 486  
   silicon-substituted, 2, 388  
   viscosity, 5, 142-154  
   benzene, 8, 285  
   bromide, 5, 141-154  
   chloride,  
     boiling point, 5, 465  
     isomers, 2, 485  
     viscosity, 5, 141-154  
   cyanide, 8, 288  
   fluoride, 5, 465  
   formate, 5, 142-154  
   iodide,  
     infrared transmission, 8, 285  
     viscosity, 5, 141-154  
   methyl ketone, 5, 142-154  
   zinc, 2, 498  
     iodide, 2, 440, 498  
     synthesis, 2, 440, 498  
 Propylamine, 1, 481  
 Propylene, 1, 482  
   azides, 7, 201-202  
   coal, from, 1, 399  
   combustion, 6, 302  
   dibromide, 5, 141-154  
   formula, 2, 193, 199  
   preparation, 2, 440, 498  
 Protium, 10, 20  
 Proto-hydrogen, 8, 40  
 Protoactinium, 8, 457  
 Protocatechuic acid, 9, 116  
 Protein, 9, 193  
   amino-acids in, 10, 218-219  
   birefringence, 10, 171  
   chromo-, 10, 236  
   denaturation, 10, 219-220, 414-415,  
     429-430  
   electric properties, 10, 431-433  
   fibrous, 10, 429  
   films, 10, 414-427

**Protein—cont.**

- globular, 10, 429
- hair, in, 9, 447
- hydrolysis, 8, 26
- molecular structure, 10, 216–223, 416, 430–431
- nucleo-, 10, 429
- sols, 10, 148
- structure, 9, 455–456; 10, 428–445
- thixotropy, 10, 171
- X-ray diffraction, 9, 455–461, 433–445

**Proton, 8, 340**

- acceleration, 9, 496–499
- aluminium nucleus, from, 9, 74–76
- bombardment, 9, 496–499; 10, 22–23, 252–253
- charge, 5, 407
- mass, 9, 7
- nuclear fission, from, 9, 13–16

**Protoplasm, 7, 61; 9, 293****Protyle, 3, 416–426; 8, 340****Prout's hypothesis, 3, 404; 5, 48; 8, 114, 340****Provitamin, 8, 376****Prussian,**

- blue as ink, 1, 104
- colloidal solution 1, 396; 2, 216–217

**Prussic acid, 1, 452; 7, 195**

- formula, 2, 197–198

**Pseudocubic structure, 7, 352****Pseudohexagonal structure, 7, 352****Pseudonone, 6, 13****Pudding's Indian, 2, 276****Pulegone, 6, 12****Pulse,**

- effect on cables, 4, 421
- electric from eye, 6, 419
- transformer, 1, 174

**Pump,**

- box, 9, 237
- Cailletet, 3, 194
- diffusion, 9, 241–244
- Gaede, 9, 235–237
- Geissler, 4, 490
- Geryk, 9, 235
- Guericke's, 9, 232–235
- history, 9, 232–244
- Haleveck, 9, 241
- Hyvac, 9, 237

**Pump—cont.**

- mercury diffusion, 4, 226–227; 7, 388
- molecular, 7, 390–391; 9, 237–244
- Ramelli, 9, 236–237
- rotary, 9, 235–237
- Sprengel, 3, 180; 4, 490
- Toepler, 9, 235
- two-cylinder, 9, 234
- vane, 9, 237
- 6-Puppis, 8, 39
- Purification of water, 1, 467–474
- Purity of water and dielectric constant, 6, 419

**Purple,**

- amethyst, 9, 165
- larkspur, 9, 115
- Tyrian, 10, 339

**Purpled window glass, 9, 164****Purpura, 10, 339****Purpurine,**

- occurrence, 2, 242
- relation to alizarine, 2, 243
- spectrum, 2, 242
- structure, 3, 172

**Putrefaction, 2, 303–304**

- at low temperature, 4, 222

**Pyramid faces, 7, 350****Pyrazol, 3, 370–371****Pyrene, 1, 399****Pyridine,**

- coal from, 1, 400
- infrared transmission, 8, 288
- phosphorescence, 4, 377
- salts, medical properties, 3, 370
- vapour, diffusion through rubber, 7, 471

**Pyrites, 2, 353****Pyrocatechol,**

- phosphorescence, 4, 377
- structure, 10, 117–118

**Pyroelectric,**

- crystals, 4, 124
- effect, 1, 297; 5, 465; 10, 172

**Pyrogallic acid, 1, 259****Pyrygallol,**

- alkaline, 4, 455
- formaldehyde oxidation, 9, 219
- phosphorescence, 4, 377
- structure, 10, 117–118

**Pyrometer, 2, 344; 5, 236–252**

**Pyrometer—*cont.***

- effusion, 5, 246–247
- gas, 5, 244–247
- limits, 7, 238
- platinum expansion, 5, 240–243
  - resistance, 5, 240–247
- radiation, 3, 87–90
- Siemen's, 4, 333
- specific heat, 5, 240–241
- thermoelectric, 2, 344; 3, 87; 5, 240–244
- transpiration, 5, 247–252
- Pyromorphite, 2, 127, 500
- Pyrophosphates, 2, 502
  - of sodium, 2, 207
  - study by Graham, 2, 207–208
- Pyrophosphoric acid, 2, 207
- Pyrophyllite, 10, 271, 288–291
- Pyrotechnics, 3, 377–393
- Pyrovanadates, 2, 502
- Pyroxylic spirit, 1, 161
- Pyrrhotite, 8, 495–509
- Pyrrrol,
  - from coal, 1, 400
  - infrared transmission, 8, 288
- Pyryllium,
  - chloride, 10, 119
  - picrate, 10, 122
  - salts, 10, 119
  - synthesis, 10, 122

**Q**

- Quadrant electrometer, 5, 53
- Quantisation,
  - angular momentum, of, 8, 227
  - energy, 8, 107
  - rotation, 9, 226–227
- Quantity of electricity, 1, 95–105, 365–369
- Quantum, 8, 515
  - electron collision, 9, 5
  - light, size, of, 8, 518–519
  - theory of, 7, 508–511; 8, 100–110, 223–226; 9, 365–385
    - line spectra, 9, 108–109
    - magnetism, 9, 88–92
    - photoelectric effect, 8, 109; 9, 192–193

**Quantum—*cont.***

- theory of—*cont.*
  - radiation, 7, 446; 8, 510–519; 9, 4–5, 201–204
  - specific heat, 7, 446
  - X-rays, 9, 4–5
- Quarter-wave plate, 2, 357
- Quartz, 7, 54
  - amethyst in, 4, 51
  - birefringence, 1, 428; 2, 274
  - black, 7, 54
  - carbon in, 9, 166
  - chemistry, 2, 383–392
  - colours from, 7, 379–380
  - compensator, 3, 529
  - Cumberland red, 4, 52
  - crystal faces, 1, 7; 5, 539–540; 7, 339–340
    - form, 1, 303; 3, 531
    - structure, 7, 337–340; 8, 321–322, 330
  - electro-optical effects, 3, 536–537; 10, 176–177
  - expansion, 4, 462
  - fibres, 3, 560–569
    - creep, 4, 368
    - load and torsion, 4, 371
    - optical properties, 3, 567
    - oscillation properties, 4, 361
    - production, 3, 564–565
    - thickness, 3, 564–565
  - gravitational effects, 5, 306
  - heat, effect of, 9, 165
  - helical structure, 7, 338–340
  - inclusion in other crystals, 4, 55
  - infrared transmission, 8, 273
  - lens, 8, 316
  - microwave birefringence, 5, 22
  - mirror images, 7, 338–340
  - occurrence, 2, 383–384
  - optic axis, 9, 283
  - optical,
    - activity, 2, 271–274; 3, 516, 524–526; 7, 379–380
    - properties, 1, 5–6, 428; 2, 274, 396–397, 405–410; 3, 516, 524–526; 5, 22; 7, 339–340, 379–380
  - oscillator, 9, 283–285
  - piezoelectric effect, 3, 536–537; 10, 176–177

**Quartz—cont.**

- plagioclal facettes, 1, 7
- polariscope, in, 4, 187
- polishing, 10, 208–211
- prism, 8, 316; 9, 225
- Raman spectrum, 9, 279–280
- reduction by magnesium, 7, 55
- silicon, free in, 9, 166
- spectrograph, 7, 82, 361
- surface refractive index, 10, 210
- symmetry, 7, 338–340
- titanium in, 9, 166
- transducer, 9, 283–285
- twinning, 7, 340
- ultraviolet transmission, 1, 89, 430–431; 4, 328–330
  - properties, 1, 428
- window, 7, 357
- X-ray,
  - diffraction, 7, 340–354, 453
  - target, 8, 50
- Quartzlite, 7, 372
- Quasi-mass, 8, 217–221
- Quenching of,
  - phosphorescence, 9, 223
  - steel, 5, 447
- Quercetin, 9, 116
- Quercitron, 9, 101
- Quercus discolor, 9, 116
- Quick-sands, 10, 156
- Quicklime,
  - bombardment with electrons, 5, 101–102
  - use as desiccant, 2, 401
- Quill, X-ray diffraction, 9, 454–457
- Quinaldine, 10, 130, 135
- Quinic acid, 6, 415
- Quinine, 1, 482; 9, 198
  - fluorescence, 1, 88, 258, 310; 4, 507
  - medical properties, 3, 369
  - occurrence, 2, 242
  - optical properties, 1, 84–89
  - projected synthesis, 1, 275
  - spectrum, 7, 359, 366
  - sulphate, 1, 258, 310
    - electrical properties, 3, 479
  - synthesis, attempted, 9, 21
- Quincke's experiment, 3, 479
- Quinoid chromophores, 5, 529
- Quinol,
  - colour, 6, 415

**Quinol—cont.**

- properties, 6, 415
- structure, 10, 117–118
- Quinoline, 3, 369–370
  - cyanine from, 10, 129
  - isocyanines from, 10, 130, 135
  - phosphorescence, 4, 377
  - sulphonic acid, 3, 370
- Quinone,
  - colour, 6, 415, 9, 20–21
  - dyes, 9, 21–25
  - preparation, 9, 20–21
- Quinones, 2, 243–244
- Quinonoid,
  - dyes, 9, 22–25
  - structure, 6, 416

**R**

- Radiant heat, 1, 305–308, 390–392, 427 (*see also Infrared*)
  - absorption by gasses, 1, 348–351
  - action on ice, 1, 252–255
  - sound from, 3, 150–158
- Radiant matter, 4, 490–492; 5, 557
- Radiation, 1, 42–48
  - acceleration, and, 8, 229–230
  - aggregation, state of, 2, 1–6
  - atoms, from, 4, 22–23; 7, 501–511
  - black-body, 1, 42–48; 8, 276–278; 9, 18
  - carbon monoxide flames from, 8, 468–469
  - cathode, 5, 99–124
  - chemistry, 7, 101–102
  - cosmic (*see Cosmic rays*)
  - crystals, by molecules in, 4, 114–115
  - cube law, 4, 225–226
  - damping, 3, 485; 4, 325–326
  - detectors, 4, 341; 6, 285–286
  - dual nature, 8, 510–519
    - electromagnetic, 4, 18–25; 8, 56–65
    - properties of, 5, 11–26
  - explosion front, from, 3, 440–443
  - heating by, 3, 378–379
    - of gases, 1, 391–2
  - hydrogen flame, from, 1, 494; 5, 468
  - infrared (*see Infrared*)
  - intensity, 8, 229

**Radiation—*cont.***

- Kelvin's work, 6, 373
- law, Planck's, 8, 276
- laws, 3, 87-89; 5, 236-240, 8, 271-278
- loss of liquefied gases, 4, 223-226
- mass, 8, 192
- measurement, 8, 253-270
- medium motion, effect of, 4, 201
- momentum, 8, 514
- observer motion, effect of, 4, 201
- penetrating, 9, 230-231
- platinum, from heated, 1, 46
- pressure, 2, 9, 442-465; 6, 150-152, 419; 8, 192, 514-515
  - discovery, 6, 150
  - gravity, and, 6, 151
  - relativity, and, 8, 515
  - sound, of, 9, 288-289
- pyrometer, 7, 238
- quantum theory, 7, 446, 9, 201-206
- relativity theory, 9, 201-204
- Röntgen, 5, 99-124 (*see also X-rays*)
- scattering, 9, 268-286
  - theory, 8, 59-60
- silica, effect on, 7, 57
- size of quantum, 8, 578-579
- solar, measurement, 1, 319-326
- source motion, effect of, 4, 201
- stray, 5, 13
- sum, from, 1, 42, 60, 319, 375
- surfaces, from, 3, 268-269
- temperature measurement, 3, 87-90
- theory, 2, 7-12, 3, 268-280
  - of black-body, 7, 446
- thermodynamics, 6, 357
- through atmosphere, 1, 422-426
- Tyndall's work, 4, 275-278
- ultraviolet, 1, 319-326, 427-434
- velocity, 9, 224
- visible, 1, 427
  - and infrared compared, 2, 330-334
- wavelength and temperature, 1, 46

**Radiator,**

- Hertz, 4, 325
- persistent, 4, 326
- various, 4, 331

**Radical,**

- ethyl, 1, 403
- organic, 1, 90, 154-155, 207-213; 2, 186

**Radical—*cont.***

- phenyl, 1, 403-404
- theory of, 2, 177-183

**Radio,**

- atomic, 8, 325-326, 381; 9, 501-502
- Bohr, 8, 59
- ionic, 9, 80, 86
- neon-like ions, of, 9, 80
- nuclear, 9, 8-10

**Radio, 5, 235**

- lead, 6, 282
- telephony, 10, 172
- transatlantic, 7, 280-281
- transmission, 10, 405-413
- waves, 4, 18-25
  - wavelength, 9, 224

**Radioactinium, 6, 278****Radioactive,**

- barium, 5, 512
- bismuth, 5, 523
- counting, 7, 182
- haloes, 8, 111-112
- isotopes, 8, 113-135; 10, 109-110
- law, change of, 8, 132
- periodic table, change and, 8, 123-124
- series, 8, 454-459
- tracers, 8, 122

**Radioactivity, 5, 508-524, 6, 40-53; 7, 501-511; 8, 222-223, 520-536**

- actinium of, 5, 512-524
- conduction of gases, and, 5, 510-511
- detection, 6, 285-286
- discovery, 5, 508
- disintegration rates, 7, 182
  - theory, 6, 275-286
- electrons from, 5, 407
- emission of electrons, 5, 560
- half-life, 6, 276-286
- induced, 5, 523; 6, 49-52
- initiation of discharge, 9, 123
- ionisation by, 5, 511
- kinetic theory of, 7, 154-163
- magnetic field, effect of, 5, 513
- nuclear structure, and, 9, 10-12
- periodic table, and, 8, 123-124, 454-459
- photographic action, 5, 508-524; 7, 312-324
- polonium, of, 5, 512-524



**Radioactivity—cont.**

- radium, of, 6, 40–53
- rays, 5, 513
- temperature, and, 6, 436–437
- thermoluminescence and, 5, 513
- thorium, of, 5, 512–524
- uranium, of, 5, 508–524

**Radiochemistry, 6, 49****Radiometer, 2, 442–465**

- Crookes', 3, 136; 5, 105; 6, 151, 257–259
  - containing argon, 4, 407
  - electric, 4, 169; 6, 260
  - explanation, 3, 40
- helium, 6, 257
- hydrogen, 6, 257–258
- mercury, 6, 260–261
- nitrogen-oxygen, 6, 258
- pressure measurement, 6, 417
- universal, 5, 434

**Radiomicrometer, 4, 333; 9, 223****Radiothorium and thorium, 8, 120**

- half-life, 6, 278; 8, 453, 457
- separation from thorium, 8, 451

**Radishes, 9, 115****Radium, 6, 40–53; 7, 64–79**

- A,
  - half-life, 6, 278; 8, 457, 530
  - polonium, and, 8, 132
- actinium, from, 7, 258
- alkaline-earth, 8, 120
- atomic,
  - spectrum, 6, 52
  - weight, 5, 53; 8, 120, 129

**azide, 7, 198****B,**

- $\beta$ -emission, 7, 503–504
- half-life, 6, 278; 8, 457
- lead, and, 7, 506
- $\beta$ -ray spectrum, 9, 12
- $\gamma$ -ray spectrum, 8, 123; 9, 12

**barium, and, 6, 52–53****bromide, 6, 47****catalysis, 7, 102–103****burning of tissue, 5, 512****C,**

- disintegration, 8, 133; 9, 10–12
- half-life, 8, 457

**C', half-life, 8, 457****C<sub>2</sub>, half-life, 8, 457****C-hydrogen reaction, 8, 456****Radium—cont.**

- C,  $\alpha$ -particles from, 8, 521
- spectrum, 9, 412–418
- cancer, use in, 6, 49
- chemical action of rays, 7, 101–102
- properties, 6, 53
- chloride, 7, 72–79
- cloud formation, 6, 64
- colouring of glass, 6, 49; 9, 164
- compounds, rate of discharge, 6, 21
- D,
  - atomic weight, 8, 133
  - electrochemistry, 8, 122
  - half-life, 6, 278; 8, 457
  - isolation, 6, 282
  - lead, and, 8, 120–123, 454
- detection, 7, 252
- discovery, 5, 512; 6, 40, 52–53; 8, 450

**E,**

- bismuth, and, 8, 122
- half-life, 6, 278; 8, 457
- synthesis, 10, 253
- effect on various substances, 5, 512
- electrons from, 5, 407
- emanation (*see Radon*)
- $\beta$ -emission, 7, 503–504
- rate of, 5, 516

**energy, 6, 89****epidermis, action on, 6, 49****eye, action on, 6, 49****F,**

- half-life, 6, 278, 8, 457

**G,**

- half-life, 6, 278

**pitchblende, in, 6, 278****helium from, 9, 313–314**

- emission rate, 6, 436–437; 7, 72–79

**half-life, 6, 276–286; 8, 112, 453, 457, 520****initiation of discharge, 9, 123****ionisation of air, 6, 42****isotopes, 8, 457****mesothorium, and, 8, 120–121****nerve centres, effect on, 6, 49****origin, 7, 247–265****parent, 6, 279** **$\alpha$ -particle from, 8, 520–536****periodic,**

- classification, 6, 53; 8, 120

**Radium—cont.**periodic—*cont.*

table, in, 6, 53; 8, 120

photographic action, 6, 49

physiological action, 6, 49

pitchblende, in, 6, 52

properties, 6, 436–437

radioactivity, 5, 512–524

 $\gamma$ -ray spectrum, 7, 505–506

rays,

chemical action, 6, 49

magnetic field, in, 6, 43

reflection, 6, 42

refraction, 6, 42

salts,

gas ionisation, 6, 17–23

heat evolution, 6, 47–49

luminescence, 6, 41

sea, in, 7, 79

series, 6, 278

silica, effect on, 7, 57

uranium,

production from, 7, 253

ratio, 6, 280

velocity of  $\beta$ -rays, 5, 413–414, 516**Radius (see also Radii)**

of combination, 8, 381

**Radon,**

atomic,

structure, 8, 226

weight, 7, 71

boiling point, 7, 71

chemical properties, 7, 71

cloud chamber, in, 7, 318

electronic structure, 8, 327

half-life, 6, 278; 8, 453, 457

inert gas, 7, 71; 8, 120

isotopes, 9, 457

 $\alpha$ -particle spectrum, 9, 413–414

periodic table, in, 8, 120

properties, 6, 282

recoil, 7, 318

vapour pressure and temperature, 7,  
71

volatility, 7, 71

**Rain,**

electric charge on, 1, 344

from sun's radiation, 1, 319

**Rainbow, 9, 323****Raising of steam, 7, 419–430****Raman,**effect, 9, 224, 228, 278–280; 10,  
405–413

source, 9, 278

spectra, 9, 279–280

**Ramelli pump, 9, 236–237****Ramie, 9, 251–252**

fibres, 9, 246

**Rankine equation, 7, 71****Raoult's law, 7, 13–15****Rare,**

earths, 1, 357

genesis, 3, 405

magnetic susceptibility, 10, 85

separation, 3, 405

spectra, 3, 405–415

gases, 7, 455–486

atmosphere, in, 7, 141

atomic structure, 8, 226

electric discharge, from, 1, 402–  
404

electronic structure, 8, 327

production, 6, 383

ratio, 7, 462

**Rarefaction, law of, 7, 172****Rate,**

diffusion in liquids, of, 1, 393–396

discharge in air, of, 6, 21

evaporation of, 2, 398–404

explosion propagation, of, 3, 440

gas evolution, of, 6, 16

isotope effect, 10, 19, 66–67

reaction, of, 8, 26

**Ratio of,**

inert gases, 7, 462

specific heats, 8, 104

for argon, 4, 408

Poisson's, 4, 371

definition, 8, 351

measurement, 8, 352

**Rational indices, law of, 7, 333****Rats, 8, 374–375****Rayleigh's law of light scattering, 3,  
431****Rayon, 9, 246****Rays,**

air, in, 4, 497

cathode, 4, 490–493; 5, 36–49, 99–  
124

history, 5, 36–37

**Rays—cont.**

- chemical, 1, 319–326, 427–434; 2, 13–21, 156–177
- cosmic, 9, 230–231, 10, 28–44
- extraordinary, 9, 547–550
- invisible, 1, 88–89
- moving media, in, 4, 192
- photographic effect of cathode, 4, 497
- pressure, 5, 105
- properties of various, 4, 502
- retrograde, 6, 323–327
- tin, 7, 161–163
- uranium, from, 5, 78–80
- velocity of retrograde, 6, 323–327
- $\alpha$ -Rays**, 6, 42, 278; 7, 154–163, 501–511
  - atomic structure, and, 8, 520–536
  - periodic table, 8, 456
  - capture by nucleus, 9, 75–76
  - charge-mass ratio, 6, 284; 7, 503
  - cloud chamber, in, 8, 521
  - counting, 8, 521
  - detection, 6, 285–286; 8, 521
  - dimensions, 9, 9–10
  - electric field, in, 8, 522–536
  - electron capture, 8, 522–536
  - energy, 9, 10
  - haloes, 8, 111–112
  - helium, and, 6, 242–247; 7, 71; 9, 313–314
  - interaction with atoms, 8, 131
  - ionisation, 6, 283; 8, 521
  - magnetic field, in, 6, 43; 8, 522–536
  - nature, 6, 43–44
  - negative, 3, 40–57
  - nuclear fission, by, 9, 13–16
  - passage through mica, 8, 524–529
  - penetration, 6, 434
  - periodic table, and, 8, 456
  - properties, 8, 520–536
  - radium, from, 8, 520–536
  - C, from, 8, 521
  - range, 9, 11
  - scattering, 8, 59, 244–252; 9, 73–76
  - aluminium, by, 9, 9–10
  - gold, by, 9, 9–10
  - tracks, 8, 521; 9, 187–188
  - velocity, 6, 282
    - decreases, 8, 521
    - half-life, and, 8, 521
    - theory of, 8, 520
- $\beta$ -Rays**, 6, 42, 278; 7, 154–163, 501–511
  - absorption, 9, 430–431
  - electrons, and, 5, 513–516
  - energy, 9, 10
  - magnetic field, in, 6, 43
  - nature, 6, 44–47
  - penetration, 5, 414
  - periodic table, and, 8, 456
  - rate of emission, 5, 516
  - $\gamma$ -rays, and, 7, 506–508
  - spectrum, 7, 504
  - velocity, 5, 413–414, 516–520; 7, 503–504
- $\gamma$ -Rays**, 6, 42, 47, 278; 7, 154–163, 501–511; 9, 411–418
  - aluminium, absorption by, 7, 505
  - characteristic, 7, 505–506
  - cloud chamber, in, 7, 319–324
  - deuterium disintegration, 10, 109
  - energy, 9, 10
  - frequency measurement, 9, 12–13
  - lead, absorption by, 7, 505
  - magnetic field, in, 6, 43
  - nature, 6, 282
  - nucleus, from, 9, 12–13
  - $\alpha$ -particle spectrum, and, 9, 412–414
  - photoelectric effect, 9, 182–192
  - quantum theory, 7, 80–89
  - soft, 7, 505
  - spectra, 7, 505–506; 9, 12–13
  - wavelengths, 9, 224
  - X-rays, and, 5, 521; 7, 501
- Razors**, 9, 97
- Reaction**,
  - autocatalytic, 9, 218
  - below flame temperature, 6, 299–300
  - branching-chain, 9, 218–219
  - chain, 9, 218–219
  - chemiluminescent, 9, 217–222
  - consecutive, 7, 248–250
  - first-order, 7, 248
  - inorganic, 8, 26
  - isotope exchange, 10, 19, 60–66
  - mechanism, 10, 384–403
    - in flames, 4, 147–149
  - metal wire, on, 6, 300
  - nuclear, 10, 22–27
  - rate, 8, 26
  - reversible, 2, 149–150
  - solid-phase, 3, 540–541
  - springs, of, 8, 361

**Reaction—*cont.***

- surface, 7, 408
- unimolecular, 7, 248
- Wedekind, 9, 219

**Reactivity, chemical, 10, 384–403****Reception of electromagnetic waves, 4, 324****Receiver of electromagnetic waves, 5, 14–17**

- microphonic, 4, 335–336
- motion, 4, 190
  - effect on frequency, 4, 196
- resonant, 4, 322
- spark-gap, 4, 19
- vacuum-tube, 4, 332

**Receivers, various, 4, 331****Reciprocity of Wheatstone's bridge, 6, 59**

- principle, 6, 59–60

**Recoil, 7, 503; 8, 246, 536**

- of radon, 7, 318

**Recorder,**

- magnetic lever, 5, 422–423
- muscle response, 5, 417–418
- pen, 1, 103–104
- syphon, 8, 358
- time-pressure, 8, 466–467

**Rectifier,**

- simple, 3, 218
- tantalum, 7, 53

**Recurrent vision, 5, 435–436****Red,**

- copper glass, 9, 158
- corpuscles, 9, 293–294
- dahlia, 9, 115
- heat, 7, 238
- lead, 4, 494
- quartz, Cumberland, 4, 52

**Reducing,**

- agents in photography, 4, 44
- methylated glucoses, 9, 54
- sugars, 7, 381–382

**Reduction by zinc-copper couple, 2, 439–441, 497–499****Reed, 8, 358****Refinery, 8, 341****Reflecting galvanometer, 4, 438****Reflection,**

- absorption, and, 1, 487–488
- coefficient of sound, 8, 369

**Reflection—*cont.*****Hertz waves, of, 4, 346****infrared, of, 2, 332; 9, 223****laws of, 5, 18****light, of, 1, 5, 242; 2, 332**

- by gold leaf, 1, 215–218, 249–251
- from magnet, 3, 533–534; 5, 176–177

**loss, 8, 275–283****method of electron diffraction, 9, 361–364****microwaves, of, 5, 18****moving medium, in a, 4, 197****multiple plates, by, 8, 282****polarisation, and, 2, 271–272****polariser, 3, 523****radium rays, of, 6, 42****refractive index, and, 8, 275–283****scattering, by, 7, 98****sound, 3, 456–458; 4, 279–280; 9, 285–289**

- multiple, 3, 494

**total internal, 1, 132–133****X-rays, 4, 488; 7, 343, 445****Reflectors, sound, 4, 241****Refraction,****acoustic, 4, 279–280; 9, 286****aggregation, state of, 6, 164****atomic, 2, 540–545****azides, of, 7, 198****corpuscles, of, 8, 511–512****demonstration, 6, 120–121****double (*see Birefringence*)****double-bond effect, 6, 157, 162****equivalent, 2, 137****evanescent, 5, 254****Hertz waves, of, 4, 347****infrared, of, 1, 45; 2, 331–332****isomerism, and, 6, 161–162****law of, 8, 511–512****light, of, 1, 122; 2, 331–332**

- theory, 3, 239

**liquids, in, 1, 132–133****microwaves, of, 5, 18****molar, 2, 136–139****moving medium, in, 4, 197****radium rays, of, 4, 502****sound, of, 4, 279–280; 9, 286****triple-bond effect, 6, 162****X-rays, of, 4, 488; 7, 445**

- Refractive index**, 2, 136-139, 540-545; 6, 98
- air, of, 3, 246
  - argon, of, 4, 449-453
  - Brewster's angle, and, 2, 170
  - carbon disulphide, of, 3, 245-246
  - change in, 1, 84-89
    - colour, with, 1, 224-226
  - chemical composition, and, 6, 153-166
  - correlations, 2, 137-139
  - crown glass, of, 3, 245-246
  - crystals, of, 5, 543-550
    - structure, 9, 462-463
  - density, and, 2, 137
  - double bond effect, 6, 157-162
  - ethyl alcohol, of, 3, 245-246
  - fluid glass, of, 3, 245-246
  - gases, of, 4, 231
  - glass, of, 3, 245-246; 5, 444-445; 9, 104
  - helium, of, 4, 454; 6, 313
  - hydrogen, of, 4, 454
  - iron carbonyl, of, 4, 212
  - lead glass, of, 2, 56-57
  - light velocity, and, 3, 239
  - limit, 1, 415
  - liquid, of,
    - air, 8, 275
    - nitrogen, 4, 259
  - measurement, 4, 449-453; 5, 19-20
  - mixtures, of, 2, 137
  - nickel carbonyl, of, 4, 211-212
  - organic compounds, of, 1, 484
  - reflection, and, 8, 275-283
  - sodium chloride in infrared, 1, 45
  - surfaces, of, 10, 208-211
  - temperature, and, 1, 299; 2, 136-137
  - theory, 2, 137-139; 3, 240-247
  - thermal expansion, and, 1, 299
  - triple-bond effect, 6, 162
  - water, of, 3, 245-246
  - wavelength, 1, 45
- Refractive power**, 6, 154
- Refractivity**,
  - ionic, 9, 81
  - gases, of, 5, 468
- Refractometer**, Jamin's interferential, 3, 323
- Refractometers**, 6, 165-166
- Refrigeration**, 2, 421; 4, 218
- Refrigeration—cont.**
- Carnot cycle, by, 6, 354
  - discovery, 5, 361
  - methyl chloride, using, 3, 31, 33-34
  - plant, 4, 457-458
    - at R.I., 5, 460
  - Regenerating coil, 4, 474; 5, 456
  - Regenerative burners, 7, 46
    - gas furnaces, 3, 377
  - Regnault's method, 4, 397
  - Reindeer hair, 4, 186
  - Rejuvenescence of crystals, 4, 50-57
- Relative**,
  - axial lengths, 7, 350
  - viscosity, 9, 168
- Relativity**,
  - generalised principle, 8, 185-197
  - light pressure, and, 8, 515
  - principle, 8, 100-110, 181-197, 214; 10, 301-331
  - theory, 8, 100-110, 181-197
    - gravity, of, 8, 102-103, 181-197
    - light, of, 9, 201-204
- Relaxation**,
  - processes, 3, 133
  - time, 9, 429-445
- Remanence**, 10, 459
- Representative points**, 7, 330
- Repulsive force**, 2, 158
  - atoms, between, 9, 79
  - molecules, between, 3, 132-133; 9, 508
- Repulsion**,
  - diamagnetic, 8, 506-507
  - eddy-current, 8, 506-507
  - electromagnetic, 4, 72-92
  - hysteresis, 8, 509; 9, 4-5
- Residual**,
  - glow, 3, 472
  - magnetism, 4, 127, 129
- Resinous electricity**, 5, 51, 56
- Resins**, 10, 257-258
- Resistance**, 1, 105 (*see also Conductance*)
  - absolute measurement, 4, 426-446
  - absolute zero, at, 4, 529-530
  - aggregation, state of, 4, 426
  - alloys, of, 4, 525-527
  - coherer, of, 4, 339
  - coil, 4, 518-519
  - comparison, 4, 426

**Resistance—*cont.***

- copper, of, 4, 99
- damping, 3, 484
- definition, 4, 426
- effect of strain, 4, 426
- electric discharges, of, 3, 224
- flames, in, 7, 3
- furnaces, 7, 239–246
- glow discharge, of, 3, 113–115
- liquid helium, in, 7, 234
- magnetic field, in, 4, 534–535
- measurement, 4, 517–521
  - Lorenz's method, 4, 430
- molecular structure, and, 4, 426
- rolling, to, 3, 452–453
- salt solutions of, 6, 93–98
- selenium, of, 3, 144
- soap films, of, 3, 319–324
- standard, 4, 426
- tantalum, of, 7, 51
- temperature, and, 2, 344, 351–352;  
4, 518–535; 5, 320, 412,  
459–461
  - low, at, 4, 229–231
- thermometer, 2, 342–352
  - limits, 7, 238
- platinum, 4, 522–524, 537; 5,  
208–212, 240–247
  - rhodium, 5, 212
- velocity, and, 4, 329–430

**Resistivity, 4, 518****Resistor,**

- glycerine-water, 3, 218
- plumbago, 3, 218

**Resolution,**

- aperture, and, 4, 66–71
- optical isomers, of, 6, 32–34
- projection microscope, of, 4, 184
- spectra, of, 3, 124
- spectroscopic, 3, 441; 4, 66

**Resonance,**

- between two pendulums, 1, 387
- demonstration, 4, 387–393
- diffused, 8, 206
- light absorption, and, 3, 123
- pendulum, 8, 200–201
- sound, and, 3, 1–7, 123

**Resonant,**

- circuit, 9, 433–440
- receiver, 4, 322

**Resonator**

- circular, 4, 326
- Helmholtz, 6, 57
- mirror, 4, 390

**Resorcinol,**

- crystal structure, 9, 450–451
- electrical properties, 9, 450–451
- phosphorescence, 4, 377
- structural formula, 10, 117–118

**Respiration in treadmill, 1, 378****Respirators, 3, 306–313**

- charcoal, 6, 395

**Response,**

- electric of,
  - metals, 5, 427–438
  - muscle, 5, 421
- mechanical of muscle, 5, 417–418
- plants, of, 5, 423–424

**Reststrahlen, 9, 223****Reticular density, 7, 346, 351****Retina, 1, 242; 2, 123; 10, 237**

- artificial, 5, 434
- effect of infrared, 1, 530
- stimulation, 5, 419
- theory of, 4, 339–340

**Retrograde rays, 6, 313–317****Reverberatory furnace, 1, 389; 3, 503****Reversal of spectra, 3, 63–79**

- demonstration, 3, 274

**Reversal, photographic, 8, 111****Reversibility, 6, 355, 358–359**

- acoustic, 2, 413–419

**Reversible reactions, 2, 149–150****Revolution, frequency of orbital, 8, 224****Revolving,**

- cylinder photography, 4, 143
- mirror, 3, 218
  - determination of light velocity, 2,  
437–438

**Rhea, 5, 23****Rheopexy, 10, 158–159****Rheoscope, 5, 247–251****Rheostat, 4, 425****Rhodanin, 7, 206; 10, 120****Rhodium,**

- atomic,
  - heat, 7, 401
  - refraction, 2, 541
  - volume, 7, 401
  - weight, 1, 500–508; 2, 325, 541
- bacteria, action on, 7, 86–92

**Rhodium—cont.**

- discovery, 2, 316–317
- platinum,
  - alloy resistance, 4, 525–527
  - at low temperature, 4, 231
  - resistance thermometer, 5, 212
  - thermocouple, 5, 240–241
- properties, 1, 352–353
- specific heat, 2, 325
- steel, 9, 97
- X-rays, 7, 451

Young's modulus, 8, 354–355

**Rhodovibrio-bacteria, 10, 236****Rhodoviolascin, 10, 236****Rhodoxanthin,**

- chromatography, 10, 231
- spectrum, 10, 232

**Rhombic,**

- bisphenoid, 10, 175
- crystal angles, 7, 351
- dodecahedron, 1, 290; 7, 335
- sulphur, 7, 22
- symmetry, 7, 330–333

**Rhombohedral, 7, 335****Rice starch, 9, 179–180****Rickets, 8, 375–376****Rifle bullet, 5, 326****Rifled guns, 1, 117–118****Rigidity, 9, 346, 349–362**

- coefficient, 8, 350; 9, 167–168
- temperature, and, 4, 266–270
- colloids, of, 9, 167–181
- definition, 9, 167
- electric discharges, of, 6, 177–178
- measurement, 8, 355–359
- for colloids, 9, 176
- melting point, and, 8, 359–360
- temperature, and, 8, 359–360
- time, and, 9, 168

**Ring, Gibb, 8, 13–18****Ringer's solution, 9, 294****Rings,**

- carbon, 6, 408–409
- coloured in water, 2, 513
- electron, 8, 131
- Newton's, 2, 374–375; 3, 60–62, 232; 8, 512–513
- acoustic analogy, 4, 241
- photography, 3, 62
- smoke, 2, 512

**Ritterian pile, 5, 484–485****River, 7, 431**

motion, 5, 215

**Roasters, 2, 276****Roasting, 7, 413****Roccellin, 3, 368****Rochelle salt, 1, 299; 9, 156**

- crystal structure, 10, 173–176
- piezoelectric effect, 10, 172–177

**Rock,**

- crystal, expansion coefficient, 4, 462
- iodine, 10, 334
- plastic deformation, 8, 292
- salt, 8, 253–254, 273
  - adsorption of water, 1, 424–425
  - cell windows, 1, 306
  - cleavage, 4, 120
  - diathermanity, 1, 43
  - electron diffraction, 9, 361
  - infrared transmission, 1, 43, 427, 530
  - lens, 1, 530
  - multiple plates, 8, 282
  - plastic deformation, 8, 292
  - prism, 1, 530; 9, 223, 225
  - refractive index, 8, 282
  - structure, 9, 79; 82, 87
  - vibrations, 1, 107–110
  - windows, 1, 348
  - X-ray diffraction, 7, 348, 353

**Rockers, Trevelyan, 3, 2****Rodents, 10, 235****Rodinal, 7, 343****Rods,**

- cones, and, 4, 339–440
- vibrating, 2, 24

**Rolling,**

- contact, 3, 451–453
- of ships, 2, 292–293

**Rontgen rays, 4, 485–510; 5, 99–124; 7, 154–163; 8, 56–65**

adsorption, 8, 47–55

atomic,

- number, and, 8, 132
- weight, and, 5, 465

astigmatism, 5, 120

cathode material, effect of, 5, 112

size, 5, 111–112

characteristic, 7, 451; 8, 58

chemical action, 7, 101

cloud,

chamber, in, 7, 319–324

**Röntgen rays—cont.****cloud—cont.**

- formation, 6, 62–66
  - collimation, 7, 343
  - coloration of glass, 9, 164
  - corpuscular theory, 9, 4–5
  - detection of soft, 7, 489–490
  - diffraction (see *X-ray diffraction*)
  - distribution of scattered, 8, 60
  - fluorescence, 7, 324; 8, 58
  - gas ionisation, 6, 17–23
  - genesis, 8, 47–55
  - isotopes, and, 8, 114
  - JKLM radiations, 8, 61–65
  - nuclear charge, and, 9, 6–16
  - optical properties, 7, 445–446
  - origin, 7, 491
  - $\beta$ -particles from, 7, 312
  - photoelectric effect, 6, 170
  - photographic intensity, 5, 122
    - of source, 5, 120–122
  - polarisation, 7, 446
    - of scattered, 8, 60
  - quantum theory, 8, 60; 9, 4–5
  - $\gamma$ -rays, and, 5, 521
  - scattered, 8, 58; 9, 4–5, 189–190, 230–231
  - secondary, 8, 58
  - soft, 7, 487–491
  - softening, 9, 189–190
  - tantalum electrodes, 7, 51
  - theory, 5, 122–124
  - tube voltage, 8, 47–55
  - wave,
    - character, 8, 60
    - theory, 9, 4–5
  - wavelength, 7, 447–454; 9, 225
  - zinc, action on, 7, 343
- Roots of violets, 6, 12**
- Rosa gallica, 9, 115**
- Rosaniline, 1, 397–412, 569–573; 2, 184–186; 3, 34**
- colour, 2, 182
  - derivatives, 2, 189
  - formula, 1, 548, 571
  - preparation, 1, 570–571; 2, 146
  - reaction with,
    - acetaldehyde, 1, 572; 2, 188–189
    - aniline, 1, 572
    - methyl iodide, 2, 189–190
  - salts, 6, 99–101

**Rosaniline—cont.**

- spectrum, 6, 99–101
  - structure, 2, 187
- Roscoelite, 2, 504**
- Rose, 9, 115**
- Bengal, 3, 368
  - quartz, 9, 165
  - red colour, 9, 23
- Rosemary, 1, 37**
- Roses, attar of, 6, 10–13**
- Rosetti's radiation law, 5, 237–240**
- Rosilic acid, 1, 400**
- Rotary pump, 9, 235–237**
- Rotating,**
- disc in earth's magnetic field, 4, 430–444
  - mirror, 9, 122–130
    - examination of arcs, 3, 108–110
    - sector, 10, 398–400
- Rotation, 1, 115–121**
- axes, 1, 115–121
  - composition of, 1, 128
  - control, 4, 433–436
  - demonstration of optical, 6, 31
  - ear, and, 8, 213
  - earth, of, 1, 13–17
    - and vortices, 10, 187–190
  - effort, 6, 369
  - internal, 9, 505–506
  - magnetic, 2, 58–67
    - field, in, 4, 82, 86
  - methyl groups, of, 9, 505–506
  - molecules, of, 2, 283–290
  - planets, of, 8, 102, 190–191
  - polarised,
    - infrared, of, 2, 333
    - light, 1, 7–8, 141–142; 2, 84–88, 333; 6, 98
    - by magnetic field (see *Faraday effect*)
  - quantisation of, 9, 226–227
  - space-time axes, 8, 184–197
- Rotational,**
- Brownian motion, 7, 180
  - energy, 5, 350–358
    - of diatomic molecule, 8, 104–105
  - momentum conservation, 6, 368
  - transitions, 9, 225–229
- Rouge, 5, 393**
- Royal Institution,**
- budget, 6, 447–448



**Royal Institution—*cont.***

Davy, and, 2, 263

Faraday, and, 2, 501–503; 4, 150–151; 9, 93–95

foundation, 6, 262

future, 1908, 6, 439–448

history, 6, 439–448

low-temperature research, 6, 391–450

refrigeration plant, 5, 460

theatre reconstruction, 9, 265–267

**Royal Society and Joule, 4, 5–6****Rubber,**

absorption of gases, 4, 5–6

bulk modulus, 8, 348

diffusion of,

gases through, 2, 38–44, 221–233

liquids through, 7, 483–486

through, 7, 470–486

at low temperature, 6, 7

elasticity and temperature, 8, 255

expansion on cooling, 8, 251–255

freezing in liquid air, 4, 263

infrared transmission, 8, 253–254, 273, 289–290

low temperatures, at, 6, 428–429

phosphorescence, 4, 377; 5, 464

Poisson's ratio, 8, 351

refractive index, 8, 275

solubility in benzene, 1, 406

solutions, viscosity, 9, 173–181

strength and temperature, 6, 7

synthetic, 10, 261

**Rubia,**

peregrina, 2, 242

tinctorium, 2, 242

**Rubiaceae, 2, 242****Rubianic acid, 2, 242****Rubidine, 1, 400****Rubidium,**

abundance, 10, 272

atomic,

heat, 7, 401

radius, 8, 326

refraction, 2, 541

spectrum, 1, 356–357; 2, 66–91, 318–320

volume, 7, 401

weight, 1, 590–508; 2, 541

chromate, 7, 327–328

**Rubidium—*cont.***

discovery, 1, 356–357, 509; 2, 316–320

ionic radius, 9, 86

magnesium selenate, 5, 544

occurrence, 1, 509, 2, 320

perchlorate, 7, 327–328

properties, 2, 319

selenate, 5, 539

crystals, 7, 327–328

{ sulphate, 5, 539, 548

crystals, 7, 327–328

zinc sulphate, 5, 540

**Rubies,**

artificial, 4, 487–509

cause of colour, 4, 235

crystal structure, 8, 321–322

jelly, 1, 250

kathodoluminescence, 4, 507–508

phosphor, 3, 51–53

polariscope, in, 4, 187

X-ray transparency, 4, 487, 509

**Rubixanthin, 10, 234****Rue, 9, 116****Ruhmkorff coil, 1, 177–179; 4, 401****Rumford, 2, 275–281\***

statesman, as, 2, 281

theory of heat, 2, 275–281

work on,

artillery, 2, 275

clothing, 2, 275–281

cookery, 2, 275–276

domestic science, 2, 275–276

heat, 3, 268–269

and work, 4, 2

transmission, 2, 275–281

naval matters, 2, 275

**Runge's blue, 2, 185****Running-in of engines, 10, 250–251****Russiberg coal, 6, 106****Rust, 6, 151****Rusting, Faraday's work, 9, 97****Ruthenium,**

atomic,

heat, 7, 401

refraction, 2, 541

volume, 7, 401

weight, 1, 500–508; 2, 352, 541

discovery, 2, 316–317

properties, 1, 352–353

specific heat, 2, 325

Rutic acid, 1, 546-547

Rutile, 7, 336

Rydberg,

constant, 8, 34-46

calculation, 8, 229

## S

Saccharimeter, 1, 8

Saccharine, 3, 372-376

discovery, 3, 373, 376

formula, 3, 372

physiological effects, 3, 375-376

production, 3, 373-375

properties, 3, 376

sweetness, 3, 372, 375-376

Safety,

lamp, 6, 299

valves, 2, 276

Safflower, 9, 101

extract, 2, 190

Safranine, 2, 190; 3, 368; 5, 533

chemiluminescence, 9, 219-220

Safrol, 6, 12

Safrosin, 3, 368

Sailing flight, 5, 294

Saint Paul's whispering gallery, 6, 60-61

Sal-ammoniac, 3, 28

Salamander, 10, 341

Salicin, 9, 543

Salicylaldehyde, 6, 12

infrared transmission, 8, 286

Salicylic acid, 1, 274

phosphorescence, 4, 377

spectrum, 7, 359-362

synthesis, 1, 271

test for, 2, 147

Salmon, 10, 236

Saltpetre, 6, 181

Salts, 1, 327-333

acid, 1, 329

colour and hydration, 2, 424-434

conduction of fused, 9, 396-400

density, 5, 540

determination in solution, 6, 166

diffusion in water, 1, 393-396; 2, 213-215

double, 1, 329

dyeing, in, 9, 23

Salts—*cont.*

flame conductivity, effect on, 7, 3-4

neutral, 1, 329

oxonium, 10, 119

precipitation, 6, 101

sea, in, 2, 276

separation,

colloids, from, 1, 395-396; 2, 215-217

diffusion, by, 1, 394

solubility in water, 3, 394

solution, 3, 543

colour, 2, 428-434

conductivity, 6, 93-95

freezing, 2, 520-526

supersaturation, 3, 394-402

volume of hydrated, 6, 2

water viscosity, 5, 146

Salvia, 9, 115

Samarium,

atomic spectra, 3, 409-415

group, 3, 409

Samaraskite, 3, 405, 9, 318

Sand, 7, 54

dilatancy, 10, 154-155

firmness, 3, 356

grains, 4, 54

granular properties, 3, 352-359

moulding, 10, 156

plasticity, 10, 155

quick-, 10, 156

separation, 1, 2

sound demonstration, for, 9, 298-311

thixotropy, 10, 156

Sang-de-Boeuf glass, 9, 158

Sanitation, 2, 305-306

Sap, 9, 115

Sapphire,

asterism, 4, 187

cause of colour, 4, 235

phosphorescence, 3, 513

Saponification, 10, 68-69

Saponified fats and oils, 9, 72

Saponin, 9, 112

solution foam, 4, 27

viscosity, 3, 318

Satellites, 1, 119-120

Saturated,

compounds and colour, 9, 18-19

**Saturated—*cont.***

- hydrocarbons, molecular structure,  
9, 508
- molecules, 1, 565–568

**Saturation,**

- acid, of, 1, 75
- current, gases, 6, 18
- magnetic, 4, 128–130
- point, 3, 284

**Saturn, 8, 226****Saucepans, 2, 276****Sauterne, 5, 259****Savart's,**

- bands, 3, 14–15, 429
- polariscope, 8, 313–314, 529

**Scale models of temperature, 7, 440–444**

- absolute, 6, 349
- Kelvin, 10, 71–72
- platinum, 4, 522–524

**Scalp, 4, 186****Scapolite, 5, 22****Scarlatina, 2, 305****Scarlet,**

- carnations, 10, 120
- Egyptian glass, 9, 155–157
- pelargonium, 9, 115; 10, 112–127

**Scattering,**

- double, 9, 363
- infrared, of, 7, 213
- light, 2, 156–177; 9, 268–280
  - atmosphere, 2, 13–21, 245–264
  - gold foil, 1, 315–318, 249–251
  - gold sols, 2, 21
  - liquids, 9, 272–273
  - molecules, 2, 261; 7, 98–99; 8, 311–317; 9, 270–280
  - particles, 2, 254–264; 8, 308–309; 9, 269–270
  - sulphur, 3, 247
  - water, 2, 256–264
  - wavelength, and, 9, 274
- microwaves, 5, 18
- $\alpha$ -particles, 9, 73–76
- photography, of, 8, 312–313
- polarisation of, 2, 172–177, 261; 3, 247–249; 7, 97; 8, 308–309
- Rayleigh's law, 3, 431
- theory of, 2, 261; 3, 248–258; 7, 97; 8, 59–60

**Scattering—*cont.*****infrared, of—*cont.***

- Tyndall's work, 4, 280–281
- ultraviolet, 7, 213
  - by sulphur, 2, 19–20
- X-rays, 9, 4–5, 189–190, 230–231
  - air, by, 4, 488
  - factor, 7, 452–453; 8, 58
  - reflection, of, 7, 98

**Scheelite, 4, 507****Schizorhis, 4, 237****Schonbein's ozone, 1, 22–24****Schumann,**

- plates, 8, 523
- region, 7, 487–491

**Science,**

- education and, 1, 35–36
- industry, and, 1, 34–41

**Scintellarein, 9, 116, 121****Scintillation,**

- counting, 7, 182
- of  $\alpha$ -particles, 8, 521
- zinc sulphide, of, 8, 244

**Screen,**

- fluorescent, 3, 257; 7, 356
- phosphorescent, 6, 233

**Screening,**

- air, and, 4, 177
- coherers, of, 4, 343–345
- coaxial, 4, 97–98
- electromagnetic, 4, 73, 93–103
- electrostatic, 4, 93–96
- frequency, and, 4, 98–99
- gratings, by, 4, 94–96
- magnetic, 5, 13
  - compass, of, 4, 96–97
  - demonstration of, 4, 101–103
- permeability, and, 4, 96
- temperature, at low, 4, 530–531

**Screw of boat, 7, 431****Scurvy, 8, 375****Sea,**

- air, 7, 461
- anemones, 10, 236
- gull's quill, 9, 454–457
- foam, stability, 9, 112
- iodine in, 10, 334
- oil on surface, 9, 110–113
- saltiness, 2, 276
- saponin in, 9, 112
- shell, 4, 472

**Sea—cont.**

thermometer, 8, 348

water,

colour, 2, 254–264; 7, 93–99

microscopic examination, 2, 256–257

radium in, 7, 79

spray, electrification, 5, 560

suspended matter in, 2, 256–257

viscosity, 5, 146

waves, 2, 292–293

**Sealing-wax,**

barium in, 7, 36

electrified, 4, 94

**Searchlights, 9, 271****Seaweed,**

iodine in, 10, 335–337

pigments, 10, 228

saponin in, 9, 112

**Second,**

definition, 4, 429

law of thermodynamics, 2, 420;  
3, 36–37; 6, 314

partial, 8, 207

sound, 10, 477

**Secondary,**

alcohols, 2, 485–487

electrons, 7, 491

spectrum of hydrogen, 8, 371–372

X-rays, 8, 58

**Sector, rotating, 10, 398–400****Sedanolide, 6, 12****Seebeck effect and temperature, 4,  
535–541****Seeding, 3, 395–402; 7, 327**

and isomorphism, 3, 397–402

**Seedlings,**

etiolated, 8, 375

green, 8, 375

**Seeds,**

low temperature, at, 4, 222; 7, 80

lycopodium, 9, 298

sunflower, 8, 375

vitamins in, 8, 375–376

**Segments, ventral, 2, 22****Seismic waves, 8, 292****Selection,**

natural, 3, 269

of particle size, 7, 174

**Selenate ion, structure, 9, 81****Selenates, crystal structure, 5, 539****Selenic acid, 1, 333****Selenious acid, 1, 333**

photoelectric effects, 3, 10

**Selenite,**

birefringence, 2, 272

cleavage, 6, 114

heat, effect of, 4, 187

infrared transmission, 8, 284

microwave birefringence, 5, 22

optical properties, 2, 173–177, 374–377; 3, 480

polariscope, in, 4, 187

**Selenium,**allotropy, 1, 56–58; 2, 468–473; 3,  
138–139

applications, 3, 138–149

atomic,

heat, 7, 401

radius, 8, 326; 9, 502

refraction, 2, 541

volume, 7, 401

weight, 1, 500–508; 2, 541

bacteria, action on, 7, 86–92

conductivity, 2, 468–477

and temperature, 3, 144

discovery, 1, 443; 2, 316–317, 467–468

fluorine, action of liquid, 6, 425

glass, 9, 160

ionic radius, 9, 86

light, action of, 2, 466–477

mass spectrum, 8, 339

optical activity, 6, 34

photocell, 2, 468–477; 3, 138–149;  
4, 336; 5, 502photoconductivity, 2, 468–477; 3,  
138–149

photophone, 3, 209

physical properties, 2, 468

preparation, 1, 443

properties, 3, 138–139

radiation detector, 4, 341

red-sensitivity, 3, 142–143

sols, 1, 21

specific heat, 6, 85–87

surface tension of liquid, 4, 118

theory of action, 4, 340'

**Self-induction, magnetic, 4, 87****Semi-colloid, 9, 71****Semipermeable membrane, 5, 391****Senarmonite, 8, 381**

- Sensation of,  
   light, 2, 123  
   motion, 8, 212-213  
   sound, 4, 384  
 Sensitisation,  
   mercury, 9, 220  
   photochemical, 9, 220  
 Sensitised plates, 4, 242  
 Sensitisers, infrared, 10, 135-141  
 Sensitising dyes for photography, 10,  
   128-141  
 Sensitive,  
   flame, 5, 197-200, 476-482; 6, 56  
   Tyndall's work, 4, 278  
   soap jets, 8, 423  
 Separation of,  
   colloids from salts, 1, 395-396  
   gases, 6, 226-228  
   by diffusion, 2, 228  
   using liquid air, 5, 155-161  
   hydrogen isotopes, 10, 18-21, 49  
   isotopes, 8, 129-130  
   mercury isotopes, 8, 339  
   minerals, 8, 500  
   oxygen isotopes, 10, 68-69  
   rare earths, 3, 405-415  
   salts by diffusion, 1, 394  
 Series,  
   homologous, 1, 478, 560-562  
   radioactive, 8, 454-459  
 Serpentine, 5, 23  
 Serrations of a spark, 3, 490  
 Serum, 10, 414  
   viscosity, 9, 170  
 Sesquioxide mordants, 5, 530  
 Sesquiterpines, 6, 12  
 Seventh, 4, 384  
 Sewer covers, 6, 395  
 Sextants, 5, 452  
 Sextets, Zeeman, 5, 269-276  
 Shading of bonds, 3, 124  
 Shadows, 6, 54-61  
   acoustic, 3, 455-465; 6, 54-61  
   bright spot in, 3, 462  
   demonstration, 6, 55  
   coloured, 2, 275  
   electrical, 4, 492-494  
   dust, 4, 503  
   film contours, of, 8, 158-159  
   wave theory, 3, 463-464  
 Shafts, mine, 8, 292-294  
 Shale, magnetism, 1, 79  
 Shape,  
   electrode, 3, 99-101, 106  
   molecules, of, 4, 115; 8, 313; 9,  
     500-510  
   spectral lines, of, 8, 236-243  
 Sharp series, 8, 35-36  
 Shear,  
   definition, 8, 346; 9, 167  
   fraction by, 8, 362  
   speed and viscosity, 9, 170-181  
 Shearing,  
   birefringence, 9, 168-169  
   stress on photographic plate, 4, 48  
 Sheep's wool, 2, 277  
 Shellac,  
   electric permittivity, 2, 78-82  
   insulator, 1, 100-101; 5, 559  
   static electricity from, 1, 263  
 Shells,  
   electron, 7, 491; 8, 131  
   number of electrons in, 8, 327  
 Shifts in spectra, 3, 132; 4, 196  
 Ships,  
   compass, 6, 372  
   compensation, 3, 19  
   effect of electrical system, 4, 97  
   screening, 4, 96-97  
   design, 2, 292-293  
   gyroscopes on, 5, 185  
   magnets for, 6, 372  
   motion of, 2, 292-293; 3, 290  
   soundings, 6, 372  
   stress on, 8, 296  
   wiring of, 4, 97  
 Shock,  
   electric, 1, 334, 5, 418  
   waves,  
     acetylene, in, 9, 491-494  
     flames, in, 9, 479-483  
     photography, 5, 326  
 Shooting, 4, 189  
 Shortt clock, 10, 100  
 Shot, packing, 3, 352  
 Shunt, glycerine and water, 3, 218  
 Sidereal iron, 2, 48, 233-239  
 Siemens's,  
   ozoniser, 8, 315  
   pyrometer, 4, 333  
 Signal,  
   generator, 4, 18-19

**Signal—cont.**

fog, 5, 478–479

**Signs of zodiac, 1, 120****Silane, 1, 331–332**

flame, 5, 32

formula, 1, 445–446, 455; 2, 385

hydroxy-, 2, 387

mass spectrum, 7, 188–192

preparation, 2, 385

properties, 2, 385

spontaneous combustion, 7, 58

trichloro-, 2, 386–388

triethoxy-, 2, 386

**Silent discharge, 7, 143****Silica, 7, 54**

adsorption, 6, 213–215

Bath springs, in, 5, 158

colloidal, 1, 396; 2, 216–217

crystal structure, 7, 337–340; 8,  
321–322, 330

fused, 6, 22

fusion, 7, 55–56

gelatinous, 7, 57

glass, in, 9, 157

hydrated, 10, 288–290

hydrofluoric acid, action of, 5, 85

insulation, 5, 162–166

mercury lamps, 7, 372

occurrence, 2, 383–384

properties, 7, 56–57

radiation, effects of, 7, 57

sheet, 10, 278

softening point, 7, 237

structure, 7, 57

surface refractive index, 10, 210

volatilisation, 7, 240

**Silicates,**

acid, action of, 7, 57

crystal structure, 9, 245, 503

earth's crust, in, 7, 54

hydrofluoric acid, action of, 5, 85

properties, 7, 57

ultraviolet absorption, 1, 430–431

X-ray diffraction, 10, 286–300

**Silicic,**

acid, 1, 331–333; 6, 102; 9, 119

gels, 2, 215–217

**Silicides, 9, 424****Silico,**

-amyl alcohol, 2, 389

-ethane, 2, 391

**Silico—cont.**

-formic acid, 2, 387

-heptyl alcohol, 2, 389–390

-hexane, 2, 389

-methyl alcohol, 2, 387

-nonane, 2, 390

-pentane, 2, 389

-phenylamide, 7, 60

-propyl alcohol, 2, 388

**Silicon, 7, 54–63**

abundance, 10, 272

alcohols, 7, 58–59

allotropy, 1, 56–58, 2, 384

ammonia compounds, 2, 391

animals, in, 7, 60–63

asymmetric atom, 7, 59

atomic,

heat, 5, 191 7, 401

radius, 8, 326

refraction, 2, 138, 541

volume, 7, 401

weight, 1, 500–508; 2, 541; 8, 340

bamboo, in, 7, 61–63

burning, 2, 385

carbon analogy to, 9, 56–59

chemistry, 2, 383–384

chlorine, action of, 2, 385

chloroform, 2, 386–388

preparation 7, 57

crystal structure, 8, 320

crystalline, 7, 55

density, 7, 55

diimide, 7, 60

dioxide (*see Silica*)

discovery, 2, 315–317

earth,

centre, in, 7, 55

crust in, 7, 54

electron diffraction, 9, 191

fluorine, action of, 5, 95–96

guanidine, 7, 60

hexachloride, 2, 385, 391

hexaethyl, 2, 391

hexahydride, 2, 391

hexaiodide, 2, 391

iron alloy, 8, 499

isotopes, 8, 339–340

nitride, 7, 59

nitrogen compounds, 7, 59–60

nuclear fission, 9, 15–16

occurrence, 9, 245

**Silicon—cont.**

- optical activity, 7, 59
- organic compounds, 7, 58–59
- plants, in, 7, 60–63
- protoplasm, 7, 61
- preparation, 2, 384; 7, 55
- quartz, free in, 9, 166
- sponges, in, 7, 63
- straw, in, 7, 61
- suboxide, 9, 220
- tetrabromide,
  - hydrolysis, 7, 57
  - preparation, 7, 57
  - reaction with thiocarbamides, 7, 60
- tetrachloride, 1, 331; 2, 385, 503
  - discharge in, 4, 287
  - hydrolysis, 7, 57
  - preparation, 7, 57
  - reaction with ammonia, 2, 391, 7, 59
- tetrafluoride, 2, 384; 5, 92
- urea, 7, 60
- valency, 5, 562
- X-ray absorption, 5, 160

**Silk,**

- artificial, 9, 246
- dyeing, 1, 410
- electrification, 5, 560
- fibres, 2, 561–562
- fibroin in, 9, 455
- heat insulation, 2, 277
- water absorption, 2, 278
- X-ray diffraction, 9, 453–455

**Siloxene, 9, 220****Silver,**

- action current, 5, 427
  - bacteria, on, 8, 86–92
  - carbon monosulphide, on, 7, 152
  - ozone, of, 2, 363
- aluminium alloy, 4, 525–527
- atomic,
  - heat, 5, 190–191; 7, 401
  - and temperature, 8, 104–106
  - radius, 8, 326
  - refraction, 2, 541
  - volume, 7, 401
  - weight, 1, 500–508, 535; 2, 325, 541; 5, 190
- atoms in magnetic field, 9, 90–91
- bismuth thermocouple, 9, 225

**Silver—cont.**

- boiling-point, 7, 237
- breaking stress, 4, 267
- bromide,
  - action on bacteria, 7, 86–92
  - infrared,
    - sensitivity, 3, 208–211
    - transmission, 8, 288
  - photography, in, 4, 43
  - sensitisation by dyes, 10, 128
  - specific heat, 6, 85–87
- chloride,
  - ammonia, solution in, 1, 21
  - bacteria, action on, 7, 86–92
  - battery, 3, 218
  - cell, 3, 91–120
    - construction, 3, 91
  - infrared transmission, 2, 5; 8, 273, 289–290
  - light, action of, 1, 202
  - multiple plates, 8, 282
  - photodecomposition, 4, 43
  - photography, in, 4, 43
  - precipitation, 2, 179
  - refractive index, 8, 275
  - rolled, 8, 253–254
  - specific heat, 6, 85–87
- chromate, 1, 129
- combustion catalysis, 7, 406–408
- coherers, in, 5, 223
- colloidal, 8, 320
- crystallisation, 2, 335–341
- cyanide, 1, 56
- eddy currents in, 3, 306–311
- electric discharge, in, 1, 314
- electrochemical equivalent, 3, 92
- electrodes, 3, 107–108; 7, 403
- electron density, 5, 412
  - absorption of, 5, 47
- equivalent weight, 5, 553
- expansion, 4, 462
- film filters, 7, 211
- fluoride,
  - action of chlorine, 5, 88
  - reduction by hydrogen, 5, 87
- foil, crystal structure, 9, 2
- gold alloy, 4, 525–527
- halides in,
  - photography, 4, 43
  - photometry, 3, 8
- heat of alloying with copper, 5, 72–73

Silver—*cont.*

- iodide,
  - crystal structure, 7, 130, 336
  - expansion, 4, 462
  - infrared transmission, 8, 288
  - layers on silver, 3, 238
  - photography, in, 4, 43
  - specific heat, 6, 85–87
- ionic radius, 9, 86
- lead,
  - phase behaviour, 2, 525–526
  - thermocouple, 4, 538
- low temperature resistance, 4, 230
- magnetic moment, 9, 91
- melting point, 5, 241, 7, 237
- neutron bombardment, 10, 256
- nitrate,
  - action of,
    - copper, 2, 335–337
    - carbon monosulphide, 7, 152
    - hydrazoic acid, 7, 197
    - sodium phosphate, 2, 206
  - effect in photography, 4, 44
  - electrolysis, 5, 553
  - solution conductivity, 6, 95
  - water eutectic, 2, 522
  - water phase diagram, 2, 523
- occlusion of,
  - carbon dioxide, 2, 48
  - carbon monoxide, 2, 48
  - hydrogen, 2, 48
  - nitrogen, 2, 48, 233–239
  - oxygen, 2, 47–48, 233, 239
- occurrence, 2, 339
- orthophosphate, 2, 502
- orthovanadate, 2, 502, 505
- oxalate, 3, 445
- oxidation by ozone, 1, 23, 7, 137
- oxide, 1, 214; 7, 197
  - action of carbon monosulphide, 7, 152
- palladium alloy, 4, 231
- peroxide, 1, 282
- phosphate, 2, 206, 502
- platinum alloy, 4, 525–527
  - low temperature resistance, 4, 231
- potassium cyanide, 5, 491
- pressure in cooling, 7, 34
- production, 1, 285
- pyrophosphate, 2, 502
- pyrovanadate, 2, 502

Silver—*cont.*

- radioactive, 10, 110–111
- rate of discharge, 6, 21
- reflection of ultraviolet light from, 1, 431
- resistance and temperature, 4, 524–527, 5, 487
  - at low temperature, 4, 231
- rigidity, 8, 360
- silver chloride photocell, 7, 82–83
- specific heat, 5, 190–191
- specific weight, 1, 325
- steel, in, 4, 158
- subchloride, 4, 479
- sun, absence from, 1, 359
- superconductivity, 9, 425
- surface tension of liquid, 4, 118
- thin film, 3, 239
- tin alloys, 9, 424–425
- trace in explosion, 3, 445–450
- trec, 2, 335, 337
- ultraviolet absorption, 3, 262
- vanadate, 2, 502
- vibrations, 1, 107, 110
- volatility, 2, 400
- X-ray,
  - absorption of, 8, 46–54
  - fluorescence, 7, 324
  - target, 8, 50
  - Young's modulus, 8, 354–355
  - Zeeman effect, 6, 208
  - zinc alloy, 5, 192
- Silvering of,
  - glass, 1, 214–215
  - vacuum vessels, 4, 225; 7, 386
- Similarity, law of dynamical, 7, 440–444
- Simple-cube, 7, 347
- Simultaneous contrast, 1, 242–243
- Single,
  - crystal of bismuth, 9, 137–138
  - wiring of ships, 4, 97
- Siren, 4, 386–393
- Sirius,
  - spectrum, 1, 433–434
  - ultraviolet spectrum, 8, 316
- Size,
  - atoms, of, 3, 227–256; 5, 556; 10, 2–3
  - molecules of, 7, 164–183
  - Young's calculation, 5, 278



**Size—cont.**

selection of particles, 7, 174

Skew, symmetry, 3, 531

**Skin,**

effect, 4, 100

friction, 7, 436

human, 4, 186

phosphorescence, 1, 309

radioluminescence, 6, 41

**Sky,**

artificial, 3, 247

blue colour, 2, 15–21, 171–177;  
7, 93–99; 8, 308–317; 9,  
268–280

light from 2, 156–177

luminosity at night, 9, 270–271

polarisation of light from, 2, 168–  
177; 7, 97; 8, 309

at night, 8, 313–314

**Slate,**

electrostatic screening, 4, 94

magnetic, 1, 191

microwave birefringence, 5, 22

thixotropy, 10, 150–158

Sliced golf-ball, 7, 104

Slide projection, 4, 187

Sliding contact, 3, 451

Slipperiness, 9, 45–47

Slits, 9, 225

Sloe, 9, 115

Slotte's formula, 5, 147–150

Slow cathode rays, 7, 487–491

**Small,**

forces, measurement, 5, 560–569

pox virus, 2, 305

Smectic liquid crystals, 9, 514–536

**Smoke,**

clearing by discharge, 5, 234

jack, 7, 15

jets, sound-sensitive, 4, 278–279

Kundt's tube, in, 9, 308

problem of, 2, 302–313

rings, 1, 439; 2, 512

Smoky quartz, 9, 165

Snail, marine, 9, 103

Snell's law, 8, 511–512

Snow, electrical charge on, 1, 344

Snowflakes, 10, 377–380

Soap, 9, 63–72

boiling, 9, 72

**Soap—cont.**

bubbles, 8, 60–99, 133–178; 9, 38–  
39, 109; 10, 446–457

absorption of water, 8, 89–99

coherence, 5, 233

columns of, 8, 142–152, 162–173

concentric half-, 8, 156–158

contraction, 8, 87–89

drainage, 8, 89–99

extensibility of columns, 8, 162–  
166

gas diffusion through, 8, 166–173

high-pressure, 8, 176–178

large, 8, 136

long duration, of, 8, 386–448

magnetism, 1, 2; 2, 96–101

multiple,

chains, 8, 142–152

columns, 8, 148–152

pressure in, 1, 131

symmetrical clusters, 8, 152–156

thickness, 3, 234–237

wire frames for, 8, 159–162

crystals, 9, 66–72

curd fibres, 9, 66–72

dilute solutions, 9, 64

effect on surface tension of water, 4,  
31–32

films, 6, 15; 9, 109; 10, 446–457

electric current, effect of, 3, 323

freezing, 4, 263

gas velocity, and, 8, 443–448

horizontal, 8, 436–443

in vacuo, 8, 6–22

optical properties, 3, 320

perforation, 8, 435–436

photography, 4, 64

plane black, 8, 136–142

production, 8, 391

resistance, 3, 319–324

structure, 9, 37–47

thinning, 3, 319–324

glycerine bubbles, 8, 71–79

jellies, 9, 71

jets,

sound-sensitivity, 9, 423

velocity, 8, 423–433

lamellar crystals, 9, 66–72

liquid crystals, 9, 65–72

micelles, 9, 67–68

perfuming, 3, 364

**Soap—cont.**

- phase rule, and, 9, 72
- solutions, 8, 388, 448–490
  - anisotropic, 9, 65–72
  - birefringence, 9, 65–72
  - conductivity, 9, 64–67
  - deco-point, 9, 64–67
  - freezing-point depression, 9, 64–67
  - osmosis, 9, 64–67
  - Plateau's, 8, 1
  - surface tension, 8, 389–390
  - ultrafiltration, 9, 64–68
  - under crossed polars, 9, 65–72
  - vapour pressure, 9, 64–67
  - viscosity, 8, 390–391; 9, 173–181
- streams, 8, 414–423
- vortices, 8, 414–423
- water hardness, and, 2, 262–264

**Soaring, 5, 294****Soda,**

- electrolysis of fused, 6, 269
- glass,
  - in, 9, 157
  - phosphorescence, 4, 492
  - viscosity, 6, 73
- X-ray absorption, 4, 487
- water, 6, 16

**Sodamide, 7, 197**

- reaction with methyl chloride, 2, 196

**Sodium,**

- abundance, 10, 272
- acetate,
  - solid-phase reactions, 3, 541
  - solubility, 3, 394
  - solution conductivity, 6, 95
  - supersaturation, 3, 399–400
  - synthesis, 2, 146
- acetic ester, 1, 575
- action of,
  - carbon monoxide, 4, 208
  - fluorine, 5, 96
  - liquid, 6, 425
  - liquid oxygen, 4, 221; 5, 465
  - ozone, 3, 472
- aluminate, 1, 536
- aluminium,
  - chloride, 1, 536; 3, 501–503
  - fluoride, 1, 536
  - production from, 3, 496–505
- amalgam, 1, 517

**Sodium—cont.**

- ammonium hydrogen arsenate, 3, 400
- antipyrine production from, 6, 273
- atomic,
  - heat, 7, 401
  - radius, 8, 326; 9, 502
  - refraction, 2, 138, 541
  - spectrum, 1, 354–359, 384, 433; 3, 65–66, 74–77; 4, 22–23
  - Zeeman effect, 5, 49; 6, 190–209
  - volume, 7, 401
  - weight, 1, 500–508; 2, 325, 541
- atoms, activated, 10, 386–403
- azide, 7, 197
  - reaction with,
    - dialo-compounds, 7, 200–201
    - organic halides, 7, 202
- band spectra, 3, 259
- behenate, 9, 69
- biphosphate, 2, 207
- bisulphate, 1, 332
- borate,
  - density, 6, 6
  - expansion, 6, 6
- bromate, 3, 516
- bromide,
  - diffusion in water, 1, 394
  - water eutectic, 2, 522
  - X-ray absorption, 4, 487
- calcium silicate, 9, 162
- carbonate,
  - decomposition, 8, 302
  - density, 6, 5–6
  - expansion, 6, 5–6
  - partial molar volume, 4, 4
  - water eutectic, 2, 522
- chlorate, 9, 279
- chloride, 5, 84
  - ammonia, effect on solution of silver chloride in, 1, 21
  - Bath springs, in, 5, 158
  - cell window, 1, 306
  - cleavage, 4, 120
  - coal fire, effect on, 8, 370
  - colloidal gold, effect on, 1, 217
  - crystal,
    - forms, 1, 303
    - structure, 3, 542; 7, 449–450; 8, 318, 321, 329; 9, 79, 82, 87
  - depression of freezing point, 6, 97

**Sodium—cont.****chloride—cont.**

- diathermaney, 1, 43
- diffusion in,
  - liquids, 1, 393–396
  - water, 2, 213–215
- electrolysis, 5, 553
- electron diffraction, 9, 361
- emission and absorption of infra-red, 1, 350–351
- flame conductivity effect on, 7, 3–4
- infrared transmission, 1, 427; 8, 253–254, 273, 289–290
- ionisation, 5, 559
- lens, 1, 530
- media, in, 7, 84
- melting point, 7, 237
- multiple plates, 8, 282
- nearest neighbour distance, 7, 451
- optical activity under compression, 4, 124
- osmosis, 2, 217
- refractive index, 4, 114; 8, 282
  - in infrared, 1, 45
- seeding by, 3, 398–399
- solution,
  - conductivity, 6, 95
  - and temperature, 4, 517–518
- specific heat, 6, 85–87
- surface tension of liquid, 4, 118
- thermodynamics of solution, 2, 422
- ultraviolet absorption, 1, 429–430
- water,
  - adsorption of, 1, 424–425
  - eutectic, 2, 522
  - phase diagram, 2, 523
  - viscosity, effect on, 5, 146
- windows, 1, 348
- X-ray,
  - absorption, 4, 487
  - diffraction, 7, 348, 353
- chlorine reaction, 7, 100
- chromate, 3, 398
- colour test, 1, 354–355
- conversion to cyanide, 6, 273
- cyanide process, 6, 273
- D line, 1, 219
- density, 6, 5–6, 269–270
- dichromate, 4, 243

**Sodium—cont.**

- dihydrogen phosphate, 1, 332
- discovery, 2, 315–317; 6, 269
- electrodes, 7, 403
- electron diffraction, 9, 191
- equivalent weight, 6, 553
- ethyl,
  - malonate, 8, 344
  - succinate, 8, 344–345
  - use in synthesis, 2, 146
- expansion, 6, 5–6
- Faraday effect in vapour, 6, 200
- ferric silicate, 9, 161
- fluorescence, 10, 387–389
  - quenching by hydrogen, 10, 388–389
- fluoride,
  - crystal structure, 8, 329
  - formula, 2, 196
- formate, 1, 480
- glass, in, 5, 445
- hydride, 3, 190
- hydrocarbon synthesis, use in, 2, 489–492
- hydrogen,
  - phosphate, 1, 332
  - seeding by, 3, 399
  - supersaturation, 3, 399
- silicate, 1, 331
- sulphate, 1, 332
- hydroxide, 1, 21
  - depression of freezing point, 6, 97–98
  - formula, 1, 450–451
  - reaction with methyl chloride, 2, 196
  - solution, rate of carbon dioxide absorption, 5, 375
- hypophosphate,
  - density, 6, 6
  - expansion, 6, 6
- hyposulphite, 3, 170
- indigo production from, 6, 273
- industrial production, 6, 272–273
- infrared transmission, 8, 284
- iodide,
  - diffusion into water, 1, 394
  - seeding by, 3, 399
  - water eutectic, 1, 522
- X-ray absorption, 6, 487

**Sodium—*cont.***

iodine chemiluminescence, 9, 220–221; 10, 389–390

ion, 5, 56

radius, 9, 80, 86

lamp, 10, 387

light,

demonstrations, for, 3, 11–12

Newton's rings from, 4, 242

optical experiments, 3, 11–17

laurate,

fibres, 9, 66–72

lamellar crystals, 9, 66–72

magnesium absorption spectrum, 3, 70, 185; 8, 273

manufacture, 3, 498–500

metallic character, 6, 270

metaphosphate, 2, 502

formula, 2, 208

metavanadate, 2, 502

methyl,

reaction with methyl chloride, 2, 196

use in synthesis, 2, 146

nitrate,

crystal structure, 8, 329

crystallisation on calcite, 7, 326–328

production 1906, 6, 181

water eutectic, 2, 522

nitroprusside,

density, 6, 6

expansion, 6, 6

photoelectric effects, 3, 10

nuclear fission, 9, 13–16

oleate, 8, 17–18, 388–448

orthophosphate, 2, 502

orthovanadate, 2, 502

oxide,

formula, 1, 450–451

reduction, 2, 150

peroxide, 1, 282

kinetics of iodide oxidation, 2, 134–135

manufacture, 6, 273

reaction with carbon monosulphide, 7, 152

phenyliodoxylate, 10, 350–351

phosphate, 1, 332; 2, 502; 3, 551

density, 6, 6

expansion, 6, 6

**Sodium—*cont.***

phosphate—*cont.*

reaction with silver nitrate, 2, 206

phosphates, formula, 2, 205

potassium alloy, 6, 269

propionate, 1, 480; 2, 146

pyrophosphate, 2, 502

acid, 2, 207

formula, 2, 207

pyrovanadate, 2, 502

salicyl aldehyde, 3, 372

selenate, 3, 398–399

silicate, 1, 332; 6, 233; 7, 57

soaps, 8, 17–18

specific heat, 2, 325

standard of length, 4, 429

stearate solution, viscosity, 9, 170–181

steel, in, 1, 513

subphosphate, 2, 207

sulphate, 1, 129–130, 332

Bath springs, in, 5, 158

diffusion into barium chloride, 5, 386

depression of freezing point, 6, 97–98

seeding by, 3, 398

solution conductivity, 6, 94–95

supersaturation, 1, 135; 3, 394–399

water eutectic, 2, 522

sulphite, 4, 44

sun, in, 1, 358, 433, 511

surface tension of liquid, 4, 118

tartrate, optical rotation by, 1, 7–8

thiosulphate,

fixer, 4, 41

seeding by, 3, 398–399

supersaturation, 3, 399–400

toluene sulphonates, 3, 373

trace in explosion, 3, 442–450

trihydrogen silicate, 1, 332

ultraviolet spectrum, 3, 259, 266

vanadate, 2, 502

preparation, 2, 124

X-ray,

absorption, 4, 488; 5, 160

scattering factor, 7, 452

xanthate, 3, 168–173

Soft,

iron, 4, 96

**Soft—cont.** $\gamma$ -rays, 7, 505

X-rays, 7, 487–491

**Softening of water**, 2, 262–264**Softness**, 8, 346, 361–362**Solar,**

atmosphere, 3, 261–262

aurorae, 1, 440

chemistry, 1, 381–389

chromosphere, 8, 32

corona, 1, 440; 2, 254–255

spectrum, 5, 459–470

eclipse, 8, 214–215

expedition to Oran, 2, 254–255

electrons, 5, 414

energy,

source, 1, 416–417

utilisation, 6, 361

erruptions, 4, 172

heat, 2, 331

light, 2, 331

mass, 5, 297

phenomena and spectrum, 8, 242

prominences, iron in, 3, 449

radiation, 1, 375

absorption in atmosphere, 3, 275–280

intensity and colour, 3, 257

measurement, 1, 319–326

spectrum, 1, 89, 385–389, 432, 510–512; 3, 179; 9, 312

A and B bands, 5, 1–2

E group, 3, 202, 205

infrared, 1, 530; 3, 210–211

limit, 8, 314–317

oxygen line, 4, 219–220

ozone, and, 8, 314–317

photography, 10, 138

ultraviolet, 3, 257, 260–261

spots, 1, 82, 435–441

and magnetism, 1, 72–73

system, 8, 224–226

temperature, 5, 236–239; 6, 381; 7, 237

**Solder,**

breaking stress, 4, 269

flow, 6, 7

**Soldering**, 1, 96

of aluminium, 3, 507

**Soleil's saccharimeter**, 1, 8**Solid,**

air, 4, 264, 460–461, 477; 5, 466–467

hydrogen, in, 4, 460–461

magnetic field, in, 4, 460

melting, 4, 460–461

removal of liquid oxygen, 4, 460

ammonia, specific heat, 6, 85–87

carbon dioxide,

at — 200°, 6, 5

density, 6, 5

expansion, 6, 5

specific heat, 6, 85–87

coherers, 4, 336

compressibility, 7, 18

elasticity, 3, 60–62

films, 8, 1–6

fluorine, 6, 424–425

reaction with liquid hydrogen, 6, 424

homogeneous, 3, 60–62

hydrogen, 5, 313–323, 466–467; 6, 381; 7, 138–141

density, 5, 319

production by charcoal, 6, 389–390

ionisation by radium, 5, 512

isotropic, 3, 60–62

liquid,

critical point, 2, 301; 7, 26

crystal transition, 9, 512–515, 536

nitrogen, 7, 138–141

oxygen, 4, 477; 5, 466–467; 7, 138–141

action of ultraviolet light, 7, 135

phase reactions, 3, 540–541

solutions, thermoluminescence, 5, 37

spectra, 3, 124

sulphur dioxide, 6, 85–87

surface, 9, 1–2

thermometer, 2, 344

transmission of heat, 2, 275–281

vaporisation, 2, 294

**Solidification of,**

ammonia, 9, 98

gases by Faraday, 9, 98

helium, 10, 453

hydrogen,

bromide, 9, 98

iodide, 9, 98

sulphide, 9, 98

nitrous oxide, 9, 98

**Solidification of—*cont.***

sulphur dioxide, 9, 98

**Solidified gases, 4, 264****Solidiscope, 4, 187****Solinckian point-systems, 7, 335****Sols,**

definition, 10, 148

dialysis, 1, 395–396

diffusion, 1, 394–395

gold, 1, 149–151, 215–218; 9, 104

filtration, 1, 250

**Solubility and surface tension, 4, 123**

of salts, 3, 394

**Soluhofen slate, 10, 150–158****Solution,**

buffer, 9, 322

chemiluminescence, 9, 219

conductivity, 6, 93–95

diffusion, and, 2, 42–44, 229–233

through rubber, 7, 484–486

electrolyte, 7, 14

heats for crystals, 9, 97

ideal, 7, 13

Plateau's, 8, 1

Ringer's, 9, 294

salt, of a, 3, 543

soap, of, 8, 388–448

solids in liquids, of, 4, 125

vapour pressure, 7, 9–15

**Solvent extraction of perfumes, 6, 4****Solvents, non-aqueous, 5, 498****Soot, analysis, 5, 33; 6, 406****Sorting demon, 3, 36–37****Sound, 3, 1–7; 9, 297–311**

absorption and resonance, 3, 123

alternating current, from, 4, 168

arcs, from, 5, 500–507

board, 8, 207–211

box, 8, 207–211

combination tones, 10, 404–413

concave surface, in, 6, 60–61

critical angle, 9, 286–287

diffraction, 7, 448

directional, 5, 481

emission, standard, 8, 363–364, 368

experiments, 1, 246–248; 2, 22–23, 413

Faraday's work, 4, 155

flames, 3, 344

effect on, 2, 31–37

moving, from, 2, 32

**Sound—*cont.***

heat, from, 3, 2

Helmholtz, work of, 4, 384–393

hot glass tube, from, 3, 3–4

inaudible, 9, 281–296

intensity, 8, 363–369

measurement, 9, 289

interference, 4, 241; 5, 476–482

lens, 3, 464–465

light, analogy with, 1, 305; 2, 1–6

light on solids, from, 3, 150

magnetism, and, 1, 523–528

motion pictures, in, 10, 133–134

multiple reflection, 3, 494

musical, 1, 246–248; 3, 1

over surface, 6, 57

quanta, 8, 516

radiant heat, from, 3, 150–158

radiation pressure, 9, 288–289

reflection, 3, 456–458; 4, 279–280; 9, 285–289

coefficient, 8, 369

reflectors, 4, 241

refraction, 4, 279–280; 9, 286

resonance, 3, 1–7

second, 10, 477

sensations, 4, 384

sensitive,

flame, 2, 31–37; 3, 344, 455–465

studied by Faraday, 2, 54

smoke-jets, 4, 278–279

soap-jets, 8, 423

shadow, 3, 455–465; 6, 54–59

central intensity, 3, 462–463

shock-waves, 5, 326

sparks, from, 3, 489

stationary waves, 3, 456–458; 9, 285–289

temperatures, from bodies of different, 1, 107–111

theory, 1, 29; 3, 2–5, 123, 454–465

total internal reflection, 9, 286–287

Tyndall, work of, 4, 278–280

transmission, 4, 248; 8, 369

velocity, 2, 413

measurement, 9, 305

water motion, from, 1, 132

wave theory, 3, 123, 454–465

wavelength, 3, 454–465

Young's work; 5, 278

**Sounding of gases, 4, 275**

Soundings, ships, 6, 372

Soups, 2, 276

Source,

motion, of, 4, 190-196

electromagnetic radiation, 4, 18-19

energy, natural, 6, 375

Hertz waves, 4, 345

infrared, 1, 348; 9, 225

light, 7, 371-378

in flames, 5, 27-35

neutrons, 10, 254

$\alpha$ -particles, 9, 414-415

solar energy, 1, 417

Raman, 9, 278

resonant, 4, 323

Sources, various electromagnetic, 4, 342

Space,

bacteria in, 5, 471

divisibility, 3, 228

Euclidean, 8, 190-197

interstitial, 7, 336

lattice, 7, 330

magnetic character, 1, 63

plenum or vacuum?, 2, 7-12

temperature, 10, 94

time relations, 8, 184-197

Spark, 1, 111-114, 277-278 (*see also Discharge, electric*)

chemical action in, 1, 278

duration, 4, 59

fluorspar, effect on, 4, 508-509

flame, 1, 112; 7, 239

length and electrode material, 3, 107-108

length effect of rays, 4, 502

magnetic field, effect of, 1, 314-318

mutual effects, 4, 327-330

photography, use in, 4, 61-71

radiation detector, 4, 341

serrations, 3, 490

sound, 3, 489

spectrum, 3, 448-449

in carbon tetrachloride, 3, 204

ultraviolet spectrum, 3, 257

light, effect of, 4, 327-330

Species, origin of, 3, 269

Specific,

gravity measurement, 4, 4

of salts, 5, 540

Specific—*cont.*

gravity measurement—*cont.*

vacuum globe, 4, 473

heat, 1, 535; 6, 85-87

air, of, 1, 253-254

allotropy, and, 5, 192

dimorphism, and, 5, 192

Einstein's theory, 7, 233-234

electrons, effect of, 8, 104

elements, of, 5, 189-196

gases, of, 5, 329-358

quantum theory, 7, 446

ratio, 5, 335, 468; 8, 104

for argon, 4, 408

steel, of, 5, 192

temperature, and, 6, 83-85, 431

low, at, 8, 104-106

thermometer, 5, 240-241

water, of, 1, 253-254

X-ray transparency, and, 4, 488

inductive capacity, 1, 264, 368-369;

5, 462 (*see also Dielectric constant*)

resistance at low temperature, 4, 229-231

copper, of, 4, 99

soap film, of, 3, 320

weight, 6, 98

Spectacles, 5, 452

Spectra, 1, 219-226

isomerism, 7, 363-366

kinetic theory, 8, 238

pressure, 8, 242

atomic, 1, 354-359; 2, 318-322;

3, 63-79, 121-135, 443

structure, 9, 226-235

auroral, 5, 469

banded,

disappearance under pressure, 3, 196

stars, of, 3, 131

broadening, 3, 443

Bunsen flames, in, 3, 448; 8, 370

carbon compounds, of, 3, 174-186

carotenoids, of, 10, 232

comets, of, 3, 179

complex formation, and, 3, 129

corona, of, 5, 469

discovery of elements in, 2, 318-322

metals, in, 1, 509-515

dissociation, and, 7, 366

**Spectra—*cont.***

- distribution of energy in, 8, 236–243
  - Doppler effect, 8, 238
  - electric field, in, 8, 239
  - energy transfer, 8, 241–242
  - explosions, of, 3, 446–447
  - flames under pressure, of, 2, 153–154
  - fluorescence of, 1, 489–491
  - gas discharges, of,
    - apparatus, 3, 204
    - moist, in, 3, 199–200
  - glow discharges, 3, 115–120
  - hydrocarbon flames, 3, 174–186
  - infrared, 9, 223–229
  - intensity, 2, 36–38
  - liquids, of, 3, 124
  - line shapes, 8, 236–243
  - magnesium, of, 3, 206
  - magnetic field, effect of, 5, 264–276
  - metals, of, 1, 384, 431–434, 510–512
  - molecular, 3, 121–135
  - nebulae, of, 5, 469
  - non-metals, of, 1, 512
  - optical isomers, of, 7, 364
  - origin and identity, 3, 174–203
  - phosphorescence, 8, 451
  - primary colours, of, 5, 126–127
  - projection, 4, 183
  - quantum theory, 8, 108–109
  - Raman, 9, 287–290
  - rare earths, of, 3, 405–415
  - $\gamma$ -ray, 7, 505–506
  - resolution, 3, 124
  - salt solutions, of, 2, 428–434
  - shift, of, 3, 132; 4, 196
  - solids, of, 3, 124
  - spark discharges, of, 3, 448–449
  - Stark effect, 8, 239
  - stars, of, 1, 433–434
  - tautomers, of, 7, 365–366
  - theory of, 7, 370
  - ultraviolet, 1, 427–434
    - elements, of, 3, 257–267
    - variations, 8, 370–373
  - Zeeman effect, 5, 264–276
- Spectrochemistry**, 6, 153–166
- Spectrometer**, 2, 393
- echelon, 7, 376–377
  - high resolution, 5, 254–255
  - home-made, 5, 392
  - infrared, 1, 306–308, 348; 9, 225

**Spectrometer—*cont.***

- mass-, 8, 332–342
  - quartz, 7, 82, 361
  - resolving power, 3, 441; 4, 66
  - ultraviolet, 1, 427–434
  - X-ray, 7, 449; 8, 318
- Spectrophotometer**, 8, 237
- Spectroscopic**,
- analysis, 3, 440–450
  - photography, 1, 427–434
- Spectroscopy and molecular physics**,
- 3, 122
  - infrared, 3, 207–215
  - organic, 7, 335–370
  - visible, 3, 63–79, 121–135
- Spectrum**,
- ammoniacal nickel sulphate, of, 1, 225
  - arc in carbon tetrachloride, of, 3, 180–182, 204
  - argon, of, 4, 407–408
  - band, 3, 124
  - Bessemer converter, of, 3, 448
  - burning magnesium, of, 1, 514–515
  - carbon monosulphide explosion, of, 7, 156
  - cathode-ray, 5, 18–19
  - celestial, 8, 237
  - chromium acetate, of, 1, 222
  - coal-gas flame, of, 3, 180, 205
  - cobalt-blue glass, of, 1, 222
  - cochineal, of, 1, 222
  - coincidences, 3, 200–203
  - copper chromate, of, 1, 223
  - cyanogen flame, in, 3, 204
  - deuterium, of, 10, 17–18
  - electric lamp, of, 9, 356
  - electromagnetic, 7, 447, 487; 9, 22–25
  - helium, of, 8, 32–46
  - hydrogen, of, 8, 32–46
  - infrared, 1, 530
    - electric lamp, of, 1, 530
    - liquid water, of, 1, 531
    - sun, of, 1, 530
  - lavender, of, 1, 222–223
  - liquid oxygen, of, 4, 219
  - litmus, of, 1, 222
  - magnesium, of, 3, 186–199
  - magnetic, 5, 108–109
  - mercury, 7, 375–389



**Spectrum—cont.**

- negative glow, 3, 127–128
  - nitrogen, of active, 7, 309
  - oxygen, of, 3, 510–515
    - in atmosphere, 4, 219–220
  - ozone, of, 3, 510–515
  - phosphorescence, of, 1, 308–313
  - potassium,
    - chromate, of, 1, 223
    - indigotate, of, 1, 223
  - radium, of, 6, 52
  - $\beta$ -ray, 7, 504
  - reversal, 1, 389, 3, 63–75
    - demonstration, 3, 274
  - solar, 1, 89, 221, 385–389, 432, 510–512; 3, 179, 427–437; 9, 312
    - E group, 3, 202, 205
    - infrared, 3, 210–211
    - limit, 8, 314–317
    - ozone, and, 8, 314–317
  - stars, of, 8, 316
  - Swann, 5, 34–35
  - thallium, of, 1, 443
  - ultraviolet, 1, 89
  - water, of, 3, 199–200
- Specular haematite,**  
hysteresis coefficient, 8, 508–509  
loss, 8, 509  
magnetic field, in, 8, 486–509
- Speculum, 9, 214**  
mirrors, 7, 213
- Speed,**  
electric transmission, of, 1, 99–105  
light, of, 1, 241; 2, 7–12  
molecular, 7, 170–171
- Spermaceti as insulator, 1, 108**  
electric permittivity, 2, 78–82
- Sphere,**  
gold, 4, 359–360  
lead, 4, 359–360  
vibration, of water, 3, 331
- Spherical,**  
aberration, 1, 122  
body, 1, 49–54  
gravitation, 4, 350  
molecules, 4, 116–118
- Spheroidal state, 1, 49–54; 2, 294**  
hydrogen, of, 6, 382  
liquid air, of, 5, 155; 6, 211
- Spherometer, 5, 392**

**Spider's**

- foot, 4, 186
  - web, 3, 565–568
- Spin,**  
concept, 6, 369  
detonation, in, 9, 481–493  
golf-ball, of, 7, 104, 118–119  
precessional, 5, 274
- Spinel, crystal structure, 8, 321, 487; 9, 81**
- Spinthariscopes, 6, 44**
- Spiral,**  
heater, graphite, 7, 241  
-spring coherer, 5, 151–157
- Spirit, pyroxylic, 1, 161**
- Splash of drops, 4, 291–320**
- Sponges,**  
iodine in, 10, 336–337  
phosphorescence, 4, 377; 5, 464  
silicon in, 7, 63
- Spontaneous,**  
generation, 2, 304  
inflammability of phosphine, 2, 208–209
- Spores in,**  
dust, 2, 302–303  
space, 5, 471
- Spots,**  
elliptical X-ray, 7, 347  
solar, 1, 82  
and magnetism, 1, 72–73
- Spread, resonance, 8, 206**
- Spreading of films on water, 10, 417–427**
- Sprengel pump, 3, 180; 4, 490**
- Springs and aether, 6, 288**  
reaction, 8, 361  
tantalum, 7, 50
- Spruce, 5, 259**
- Spun glass, 3, 561–562**
- Sputtered films, 9, 362**
- Square,**  
law of radiation, 3, 87–88  
planar structure, 9, 503
- Stains, 9, 17–25**  
for microscopy, 6, 120
- Stalloy, 8, 499**  
hysteresis, coefficient, 8, 508  
loss, 8, 509  
planes of force, 8, 505–506

**Standard,**

- bars, 4, 363
- cell, 5, 452
- electrical, 5, 452
- emission of sound, 8, 363-364, 368
- flatness, of, 4, 243
- kilogramme, 10, 15
- length, of, 4, 428-429
  - sodium, 4, 429
- mass, of, 4, 428-429
- ohm, 4, 427
- resistance, 4, 426

**Standardisation of glass vessels, 5, 452****Standing waves (*see* *Stationary waves*)****Stannic,**

- acid, 1, 333
- colloidal, 2, 216-217
- chloride,
  - active nitrogen, 7, 310
  - electrolysis, 5, 490-491
  - formula, 1, 536
  - osmosis, 2, 217
  - reaction with aniline, 1, 408

**Stannous chloride, electrolysis, 9, 401****Starch, 6, 39; 9, 71**

- colloid, 9, 67
- formula, 9, 50, 58-62, 246
- granules, 9, 67
- indigo dyeing, use in, 3, 169-173
- iodide indicator, 1, 22; 7, 70
- iodine, reduction by hydrogenised
  - palladium, 2, 47, 233-239
- micelles, 9, 67
- photosynthesis, 5, 372; 9, 193-200
- solution, viscosity, 9, 173-181
- vacuum distillation, 9, 60

**Starfish, 10, 236****Stark effect, 8, 239****Stars,**

- aberration, 4, 195; 5, 325
- apparent position, 4, 191
- band spectra, 3, 131
- binary, 4, 350
- birth of, 8, 237, 243
- carbon spectrum, 8, 371
- class O, 8, 371
- diameter, 8, 579
- energy source, 9, 264
- helium in, 9, 312
- hydrogen in, 8, 32
- infrared emission, 9, 227

**Stars—*cont.***

- pressure on surface, 3, 121
- spectra, 1, 433-434
- spectroscopy, 3, 121, 131
- temperature, 3, 121, 131; 9, 227
- ultraviolet spectra, 8, 316
- Wolf-Raynet, 8, 40, 371

**State,**

- aggregation, of, 2, 1-6
  - absorption, and, 1, 492-493
  - resistance, and, 4, 426
- change of, 7, 17
- matter, of, 1, 281; 2, 294-301; 4, 104-113

**fourth, 5, 551**

- refraction, and, 6, 164
- spheroidal, 1, 49-54; 2, 294
  - hydrogen, of, 6, 382
  - liquid air, of, 6, 211
- stationary, 8, 42; 9, 202-204
- utricular, 6, 222

**Static electricity, 1, 263-267****Faraday's work, 2, 78-82****Stationary,**

- state, 8, 42; 9, 202-204
- waves, 2, 22
  - sound, 3, 456-458; 9, 285-289

**Steam,**

- calorimeter, 5, 193
- carbon monoxide combustion, effect
  - on, 8, 468
- cooking, 2, 276
- dissociation, 7, 406
- distillation, 6, 11
- engine, 1, 182, 235; 2, 420
- flame velocity, effect on, 4, 146
- gauges, 5, 451
- heat capacity, 4, 144
- heating, 2, 276
- raising, 7, 419-430
- stoves, 2, 276
- vibrationally excited, 8, 468-569

**Stearic acid,**

- film on water, 9, 40
- formula, 1, 546-547
- infrared transmission, 8, 287

**Steel,**

- aluminium, 3, 508-509
- amalgamation, 8, 294
- annealing, 5, 447
- Bessemer process, 1, 512-513

**Steel—cont.**

- breaking stress, 4, 167
  - chromium, 9, 214
  - crystallinity, 5, 447
  - cyclic magnetisation, 4, 425
  - elasticity, 8, 360–361
  - electrical,
    - melting, 7, 374–377
    - properties, 5, 447
  - Faraday's works, 2, 55; 4, 158; 9, 97
  - formation, 2, 48, 233–239
  - high-speed, 7, 34
  - hysteresis, 4, 511
    - coefficient, 8, 508
  - lead thermocouple, 4, 538
  - low-loss, 5, 448
  - magnetism, 5, 447; 10, 458
    - at low temperatures, 4, 541–548
  - making, pinch effect, 7, 374–377
  - manganese, 9, 214
    - resistance and temperature, 4, 525–529
  - manufacture, 3, 448
  - metal fatigue, 10, 225–226
  - nickel, 4, 158
    - resistance and temperature, 4, 525–529
  - oxide layers, 3, 237–238
  - permeability and temperature, 4, 542–545
  - planes of force, 8, 506
  - platinum, 4, 158
  - quenching, 5, 447
  - silver, 4, 158
  - specific heat, 5, 192
  - structure and history, 5, 447
  - temperature, 5, 447
    - effect of low, 6, 425–426
  - thermal conductivity, 6, 213
  - trace metals in, 1, 513
- Stefan's fourth power law, 5, 237–240; 8, 271–272**
- Stereochemistry, 5, 560; 6, 24–39**
- Stereohedra, 7, 335**
- Stereoisomers, 6, 26–39**
- Stereoscope, invention, 4, 394**
- Sterilisation, 2, 303**
  - of water, 7, 378
- Stern–Gerlach experiment, 9, 90–92**
- Sterol, 9, 461**
- Steroptane of otto of roses, 1, 37**
- Stewpans, 2, 276**
- Stibnite, 8, 275**
- Stilbethylum, 1, 139**
- Stilbine, 1, 206, 209, 330**
  - formula, 1, 455
  - oxygen explosion spectra, 3, 447
- Stimulus, 5, 417–440**
- Sting, 4, 186**
- Stoke's,**
  - law, 7, 176
    - of fluorescence, 8, 184
    - theory of fluorescenc., 3, 250–254
    - phosphorescence, 3, 245, 250–254
- Stomates, 5, 372–391**
- Stopping, 4, 185**
- Storage,**
  - cell, 6, 375
  - liquefied gases, of, 4, 223–229
- Storms, magnetic, 1, 435–441**
- Stoves, 2, 276**
- Strain,**
  - birefringence, 7, 329
  - in colloids, 9, 167
  - crystals, in, 4, 124
  - cyclic, 10, 225–226
  - resistance, effect on, 4, 426
- Straw,**
  - dust in, 2, 302–303
  - silicon in, 7, 61
- Stray radiation, 5, 13**
- Streamer discharge, 3, 108–110**
- Streaming,**
  - birefringence, 10, 165–167
  - tobacco mosaic virus, of, 10, 220–222
- Streamlines, 5, 215–232**
- Streams,**
  - falling, 6, 72–73
  - lava, of, 3, 299
  - soap solution, of, 8, 414–423
- Strength,**
  - diamond, of, 8, 361
  - hydrogenated palladium, of, 2, 239
  - materials, of, 8, 361
  - tensile, 2, 276
- Streptococci, 9, 295**
- Stress,**
  - breaking and temperature, 5, 462
  - cyclic, 10, 225–226
  - electrical, 3, 478–480

**Stress—cont.**

magnetisation, and, 3, 18–20, 282; 4, 130

superconductivity, and, 9, 425

**Stretched string (see *String*)****Stretching,**

bonds, of, 9, 506

liquid films, 3, 236–237

Striations, 1, 277–278, 316–318; 2, 546–549; 3, 95–96, 115–120, 224; 7, 36–45

critical, 2, 295

luminosity, 7, 44–45

theory, 7, 36–45

voltage in, 7, 37–45

String, vibrating, 1, 246; 2, 22–23; 8, 207

density and frequency, 2, 30

diameter and frequency, 2, 29

length and frequency, 2, 29–30

tension and frequency, 2, 29–30

Stroboscope, 4, 436–437

Stroboscopic viewing of flames, 2, 32–33

Strontium, 1, 284–289

abundance, 10, 272

atomic,

heat, 7, 401

radius, 8, 326

refraction, 2, 541

spectrum, 1, 354–355, 384; 3, 74–78, 409, 413; 8, 370

volume, 7, 401

weight, 1, 500–508; 2, 541

Bath springs, in, 5, 159

bromide, 8, 370

carbonate, 9, 543

chloride,

depression of freezing point, 6, 97–98

spectrum, 8, 370

water eutectic, 2, 522

colour test, 1, 354–355

discovery, 2, 316–317

ionic radius, 9, 86

nitrate, 2, 522

oxide, 8, 370

peroxide, 1, 282

platinocyanide, 4, 510

sulphide, 1, 310–312

Struck strings, 8, 207

**Structure,**

anions, of, 9, 81

atomic, 4, 23; 5, 48, 409; 6, 135; 7, 502; 8, 113–135, 221–226, 327

$\alpha$ -particles, and, 8, 520–536

spectra, and, 8, 226–235

X-rays, and, 7, 451

biological molecules, of, 9, 446–464

charcoal, of, 6, 406–417

chemical, 2, 177–183, 194

boiling point, and, 2, 182

colour, and, 2, 182

crystal, 5, 538–550; 7, 120–134, 445–454; 8, 318–331; 9, 1–3, 214–216, 245–260; 10, 210–226

alloys, of, 9, 214–215

expansion, and, 8, 382

inorganic, of, 9, 77–87

magnetism, and, 1, 193–195

deuterium nucleus, of, 10, 21

earth, of, 7, 16

electronic, 8, 327

active nitrogen, of, 8, 486–487

nitrogen, of, 8, 486–487

liquids, of, 9, 323–324

loaded, 8, 361

magne-crystals, of, 9, 131–154

metal foils, of, 9, 2

molecular, 1, 4, 154–157, 554–568; 3, 547; 8, 313

and resistance, 4, 426

nuclear, 8, 341; 9, 6–16

and radioactivity, 9, 10–12

organic crystals, 8, 378–385

protein, of, 10, 428–445

films, of, 10, 414–427

soap jellies, of, 9, 71

surfaces, of, 10, 244–257

Strychnine, 1, 482

physiological action, 2, 182

spectrum, 7, 366–368

sulphate, optical activity, 4, 124

Styrene, polymerisation, 1, 56

Sub-

chlorides,

formation, 5, 37

lyoluminescence, 4, 507

millimetre waves, 7, 487

phosphate of sodium, 2, 207

**Sub—cont.**

- stage condensers, 4, 184
- Subatomic particles, 5, 404-416
- Submarine,
  - cables, 6, 366-367
  - dynamics, 7, 436
- Substitution,
  - chemical, 3, 546
  - isotopic, 10, 63-64
- Substrate-enzyme compounds, 8, 29-31
- Successive contrast, 1, 242-243
- Succinates, Kolbé electrolysis, 8, 344-345
- Succinic acid, 1, 274
  - formula, 1, 454, 542
  - glycol polymerisation, 10, 268-269
  - synthesis, 2, 144
- Sucrates, 1, 396
- Sucrose, 9, 71
  - in chromatography, 10, 229
- Sudbury ore, 8, 495-509
- Sugar,
  - allotropy, 1, 37
  - analysis, 3, 527
  - beet,
    - breeding, 9, 102
    - industry, 3, 30-35
    - sugar content, 9, 102
  - boiling point elevation, 1, 14
  - carbon,
    - analysis, 6, 406
    - compression, 8, 303
  - chemistry, 9, 48-62
  - concentration, 7, 423-424
  - decomposition, 1, 475-482
  - dehydration, 1, 158-159
  - depression of freezing point, 6, 97-98; 7, 14
  - fermentation, 1, 56
    - by zymase, 6, 36-37
  - methylation, 9, 53-55
  - mutarotation, 7, 381-382
  - optical activity, 3, 516
  - osmosis, 7, 5
  - partial molar volume, 4, 4
  - photosynthesis, 5, 372; 9, 193-200
  - silicon in, 7, 61
  - solution,
    - diffusion through rubber, 7, 485
    - relative viscosity, 9, 168

**Sugar—cont.**

- spectra, 7, 358, 363
- triboluminescence, 4, 507
- water, diffusion in, 1, 394
- X-ray diffraction, 7, 353
- Sulcataxanthin, 10, 236
- Sulphate, 1, 329, 332-333
  - birefringence, 9, 81
  - crystal structure, 5, 539; 7, 337
  - esters, 1, 329
  - heat of hydration, 2, 210-211
  - ion, structure, 9, 81-86
- Sulphides,
  - from carbon arc, 3, 80-81
  - precipitation, 5, 498
  - X-ray absorption, 4, 487
- Sulphindigotate of potassium, 1, 223
- Sulphindigotic acid, 1, 221
- Sulphites, oxidation kinetics, 2, 134
- Sulphocyanides, 1, 128
- Sulphonic,
  - acid dyes, 9, 22
  - group, auxochromic character, 5, 529
- Sulphovinic acid, 1, 19
- Sulphur,
  - abundance, 10, 272
  - allotropy, 1, 36-37, 56-58, 134-135; 7, 22-28
  - atomic,
    - heat, 5, 190; 7, 401; 8, 326; 9, 502
    - refraction, 2, 137-138, 541
    - volume, 7, 337, 401
    - weight, 1, 500-508; 2, 541; 5, 190; 8, 340
  - bacteria, action on, 7, 86-92
  - boiling point, 7, 237; 8, 272
  - burning, 2, 286-287
    - in liquid oxygen, 4, 233-234
  - carbon mixtures, light-sensitivity, 4, 336
  - coal,
    - gas, in, 2, 353-356
    - quantity, in, 2, 354
  - coherers, in, 4, 336
  - compounds, viscosity, 5, 141-154
  - density, 6, 5-6; 7, 22
  - diamagnetism, 1, 192
  - dichloride, 1, 329
  - dielectric properties, 1, 266-269
  - diffusion pump, 4, 229

**Sulphur—*cont.***

- dioxide,
  - absorption of electrons, 5, 47
  - adsorption on charcoal, 6, 105, 395
  - boiling-point, 6, 75–77, 427
  - coal, from, 1, 399
  - gas, burnt, from, 2, 353–354
  - corrosive action, 2, 354
  - critical point, 2, 297; 3, 315
  - critical temperature, 6, 75, 427
  - density, 2, 154
  - of solid, 6, 77
  - electric discharge in, 2, 154
  - evaporation temperature, 6, 75, 429
  - hydrogen sulphide reaction, 7, 102
  - infrared transmission, 8, 284
  - ionisation detector, 7, 490
  - latent heat of evaporation, 6, 77, 431
  - liquefaction, 3, 22; 9, 98
  - liquid, 4, 457
  - saturation current, 6, 18
  - solid, 3, 22
  - solidification, 9, 98
  - specific heat of solid, 6, 85–87
  - ultraviolet,
    - absorption, 1, 430–431
    - spectrum, 3, 263
- distillation, 4, 229
- electric,
  - discharge in, 1, 470
  - permittivity, 2, 78–82
- electron,
  - diffraction, 9, 191
  - number of, 8, 58
- expansion, 6, 5–6
- fluorine, action of, 5, 95
- liquid, 6, 425
- infrared absorption, 1, 390
- ionic radius, 9, 86
- isotope, 8, 339–340
- lens, 5, 16
- light-scattering, 3, 247, 431; 4, 280; 8, 308–309
- ultraviolet, 2, 19–20
- liquid, 1, 56–57
- magnetism, 1, 68
- mass-spectrum, 8; 339–340
- melting point, 1, 134–135

**Sulphur—*cont.***

- mercury, action of, 6, 219–225
- molecular spectrum, 3, 126
- molecule, 6, 222
- moon, on, 7, 217
- native, 7, 22
- nickel carbonyl, action of, 4, 209
- nitrogen compound, 7, 311
- non-conductor, 5, 559
- nuclear fission, 9, 15–16
- optical activity, 6, 34
- oxidation, 9, 219
- oxygen,
  - flame, 1, 88
  - reaction, 7, 100
- phase diagram, 7, 21–28
- plastic, 1, 57, 135
- pressure effects, 7, 21–24
- protoplasm, in, 7, 61
- refraction of microwaves, 5, 18, 20
- sols, 2, 21
- solubility, 4, 123
- solution, in, 5, 195
- specific heat, 5, 190; 6, 85–87
- spectrum, 1, 512
- static electricity, 1, 263
- supersaturation, 1, 135
- surface tension of liquid, 4, 118
- tetrachloride, 1, 142
- trioxide, 5, 491
- lime reaction, 7, 100
- vacua, for making, 4, 229
- valency, 3, 545; 5, 562
- vapour,
  - pressure, 6, 219–225, 421–422
  - spectrum, 3, 126
- vessels, 5, 88
- X-ray,
  - absorption, 5, 160
  - action, of, 7, 345
- Sulphuric acid, 1, 74–75, 329, 331–333
- acetaldehyde, action of, 1, 56
- basicity, 5, 497–498
- boiling, 1, 467
- carbon monosulphide, action of, 7, 152
- coal-gas, from burnt, 3, 353–354
- corrosive action, 2, 354
- desiccant, use as, 2, 401
- dissociation, 5, 491
- electrolysis, 8, 343–344

**Sulphuric acid—*cont.***

- etherification, in, 1, 19
- heat of solution, 2, 210–211
- hydrate, 2, 210
- infrared,
  - absorption, 8, 284
  - spectrum, 3, 213
- iron, action of concentration on, 6, 96
- liquid air on, 6, 211
- magnetism, 1, 68
- manufacture, 1, 162
- maximum conductivity, 5, 491
- phosphorescence, 4, 377; 5, 464
- spherical drops, 1, 51
- superheating, 1, 467
- viscosity, 2, 212–213
- water mixtures, 2, 212–213
- Sulphuric ether, 1, 349
- Sulphurous acid, 1, 75, 329, 333
- Sulphurous photoelectric effects, 3, 10
- Sulphuryl chloride, 1, 329
- Sun,

- altitude and light scattering, 2, 17–18
- annual variation in intensity, 2, 13–21

- atmosphere, 3, 261–262
- blue, 2, 21; 3, 435
- brightness measurements, 3, 427–437
- carbon in, 3, 175
- chemistry, 1, 381–389
- chromosphere, 8, 32
- climate, effect on, 1, 425–426
- comet tail, and, 6, 150
- corona, 2, 254–265
  - spectra, 5, 469–470
- eclipse at Oran, 2, 254–255
- electrons from, 5, 414
- elements in, 1, 357–359
- energy,
  - source, 1, 416–417; 9, 264
  - utilisation, 6, 361
- eruptions, 4, 172
- fog, in, 3, 427
- heat from, 2, 331
- helium in, 9, 312
- infrared,
  - emission, 9, 227–228
  - spectrum, 1, 530; 3, 210
- iron in, 3, 449
- light from (*see Sunlight*)

**Sun—*cont.***

- mass, 5, 297
- photochemical action, 1, 202, 456–462
- photosynthesis, 1, 456–462; 9, 193–200
- pressure,
  - at centre, 8, 348
  - on surface, 3, 121
- radiation, 1, 60, 375
  - intensity and colour, 3, 257
  - measurement, 1, 319–326
  - pressure, 8, 192
- spectrum, 1, 89, 221, 385–389, 432, 510–512; 3, 121, 131, 427–437; 9, 312
  - A and B bands, 5, 1–2
  - E group, 3, 202, 205
  - infrared, 1, 530; 3, 210
  - limit, 8, 314–317
  - oxygen lines, 4, 219–220
  - ozone, and, 8, 314–317
  - photography, 10, 138
- spots, 1, 82, 435–441
  - and magnetism, 1, 72–73
- temperature, 1, 374, 432, 3, 121, 131; 5, 236–239; 6, 381; 7, 237; 9, 227
- ultraviolet,
  - emission, 1, 428; 2, 13–21
  - spectrum, 3, 259–262; 8, 316
  - variation over disc, 1, 461–462
- Sunflower,
  - loss of water, 2, 402
  - seeds, 8, 375
- Sunlight, 2, 331
  - benzene chlorination by, 9, 99
  - colours, 3, 427–437
  - glass, effect on, 2, 56; 9, 164
  - photosynthesis, in, 9, 193
  - pressure, 6, 150
  - rickets, and, 8, 375
  - strength, 9, 271
- Sunset, red, 2, 432
- Super-sensitive dyes, 10, 133
- Superconductivity, 9, 315, 419–445
  - A.C., using, 9, 429–445
  - alloys, of, 9, 424–425
  - compounds, of, 9, 424
  - current, maximum, 9, 426
  - demonstration, 10, 74–75

**Superconductivity —cont.**

frequency, and, 9, 429–445  
 magnetic field, in, 9, 425–429  
 stress, and, 9, 425

**Supercooling,**

tetrahydroquinoline, of, 7, 121  
 water, of, 1, 135

**Superheating,**

liquids, of, 4, 110  
 sulphuric acid, of, 1, 467  
 water, of, 1, 467–474

**Superior limit of density, 5, 322****Supersaturated solutions, seeding, 3, 395–402****Supersaturation, of, 1, 135**

borax, 1, 135  
 salts, 3, 394–402  
 sodium sulphate, 1, 135  
 sulphur, 1, 135  
 theory, of, 3, 400  
 two salts, 3, 399–400  
 vapour, 6, 62  
 water vapour, 4, 111

**Suppression of heat, 8, 468****Surface,**

acoustics of concave, 6, 60–61  
 activation, 7, 408  
 attraction of concave by jet, 7, 438  
 chemical effects, 1, 160–161  
 combustion, 7, 405–430  
 concentration and surface tension, 9, 111–112  
 crystal, of, 4, 118–149  
 dissociation, effects in, 3, 377–393  
 electron diffraction, 10, 244–251  
 energy and cleavage, 4, 120  
 film compression, 9, 110–111  
 fourth state of matter, 9, 109  
 hardness, 8, 361  
 hemispherical of liquid, 3, 346  
 layer, thickness, 3, 319–324  
 living cells, of, 9, 109  
 liquids, properties of, 3, 318–324  
 mercury, effects with, 3, 341  
 molecules on, 9, 1–2  
 oxidation, 6, 300  
 platinum, cleaning of, 8, 28  
 poisoning, 9, 2  
 polishing, 10, 208–211, 247–248  
 porcelain, of, 9, 109  
 potential, 10, 395

**Surface—cont.**

pressure, 10, 420  
 refractive index, 10, 208–211  
 sound over, 6, 57  
 structure, 10, 244–251  
 tension, 4, 114; 6, 15–16; 8, 1–26; 10, 1–14  
 critical point, and, 4, 109  
 demonstration, 2, 333–337; 4, 27–28  
 drops, and, 10, 7–14  
 hardness, and, 8, 361  
 heat, and, 3, 348  
 liquids, of, 4, 118  
 molten metals, of, 4, 118  
 motion, from, 4, 29–31  
 oxygen, of liquid, 4, 218  
 soap solutions, of, 8, 389–390  
 solubility, 4, 125  
 surface concentration, 9, 111–112  
 theory, 8, 511; 10, 3–4  
 temperature, 10, 5  
 work, 10, 4

**theory of capillary, 3, 337–341****viscosity, 3, 318; 4, 35–37****water, flatness, 4, 244****Susceptibility,**

anisotropic, 10, 146–147, 172–177  
 magnetic, 9, 89; 10, 85–98  
 crystals, of, 10, 142–147  
 gases, of, 9, 91–92  
 liquid oxygen, of, 5, 4–10  
 measurement for liquids, 5, 4–10

**Suspended,**

crystallisation, 3, 394–402  
 wire radiation detector, 4, 341

**Suspensions, 9, 179****Suspensoid, 9, 71****Swan lamp, 4, 342****Swann bands, 3, 174–186; 5, 34–35****Sweat ducts, 4, 186****Sylvestrene, 6, 12****Sylvine, 7, 449–456****prism, 9, 225****Symmetrical clusters of bubbles, 8, 152–156****Symmetry,**

classes, 7, 333  
 crystal, 1, 293; 4, 122; 5, 539; 7, 122–134  
 lattice, 7, 330



**Symmetry—cont.**

- molecular, 4, 122
- skew, 3, 531

**Synthesis,**

- acetic acid, of 1, 270–271
- alkaloids, projected of, 1, 275
- dyes, 2, 184–192, 240–245
  - projected of, 1, 275
- economics of, 1, 275
- electrolytic, 8, 343–345
- metal–organic compounds, by 1, 518–522
- natural colours of, 10, 112–127
- organic, 1, 270–276, 475–482; 2, 140–147
- polysaccharides of, 9, 60–61
- sodium acetic esters by 1, 575
- urea, of, 1, 270

**Synthetic rubber, 10, 261****Syntony, electric, 4, 326****Syphon,**

- recorder, 8, 358
- vacuum, 7, 64–66

**System,**

- solar, 8, 224–226
- units of, 4, 427–430
- teaching, 3, 228–229

**T****Tabasheer, 7, 61–63****Table of colours, Newton's 3, 320****Tactoids, 10, 169–170****Tadpoles, 10, 341****Tails, comet, 6, 150****Talbotype process, 4, 41****Talc,**

- hardness, 8, 361
- structure, 10, 271, 291

**Talose, 6, 38****Tantalite, 7, 48****Tantalum,**

- absorption of gas, 7, 50–51
- atomic,
  - heat, 7, 49, 401
  - refraction, 2, 541
  - volume, 7, 401
  - weight, 1, 500–508; 2, 541; 7, 48
- bacteria, action on, 7, 86–92
- boride, 9, 424

**Tantalum—cont.**

- carbon impurity, 7, 48
  - carbide, 9, 424
  - cataract knife, 7, 50
  - chemical properties, 7, 49
  - combustion, 7, 81
  - density, 7, 48, 51
  - discovery, 2, 316–317
  - electrodes, 7, 51
  - filament, 7, 47–53
  - heat conductivity, 7, 49
  - heating in air, 7, 51
  - industrial applications, 7, 46–53
  - instruments, 7, 50
  - malleable, 7, 48
  - melting point, 7, 51, 327
  - niobium, separation from, 7, 48
  - nitride, 9, 424
  - occurrence, 7, 48
  - oxide film, 7, 53
  - pens, 7, 50
  - pentoxide, 7, 48
  - physical properties, 7, 49
  - potassium fluoride, 7, 48
  - preparation, 7, 48
    - pure, 7, 74
  - purification, 7, 48
  - rectification, 7, 53
  - resistance, 7, 51
  - silicide, 9, 424
  - specific heat, 7, 49
  - spring, 7, 50
  - superconductivity, 9, 427–445
  - tensile strength, 7, 49
- Tar, hydrogenation, 9, 344–358**
- Taraxanthin,**
- chromatography, 10, 231
  - occurrence, 10, 234
- Tartar emetic, 10, 175**
- Tartaric acid, 1, 214**
- d-, 6, 33
  - formula, 1, 454, 542
  - mould consumption, 6, 36
  - optical activity, 1, 7–8
  - synthesis, 2, 144–145
- Tartrate, sodium potassium, 1, 299**
- Tartrates, optical activity, 1, 7–8; 4, 124**
- Tautomerism, 6, 165**
- and spectra, 7, 365–366

**Tea,**

- action on photographic plate, 5, 259
- kettles, 2, 276
- making, 2, 262-264
- rubidium in, 2, 320

**Teaching of units, 3, 228-229****Tears, 6, 130**

- of ethyl alcohol, 3, 347-348

**Techu atmospheric burner, 9, 472****Telegraph, 4, 323**

- Atlantic, 6, 366-367
- clock, 4, 437
- electric, 1, 240; 8, 216
- wireless, 5, 235; 7, 291

**Telephone, 3, 145; 4, 323**

- booths, 8, 367
- experiments with, 5, 197-200
- frequency, 7, 266
- minimum current, 5, 197-200
- radio-, 10, 172

**Telephotography, 3, 138-149****Telescope,**

- Gallilean, 1, 261-262
- mirrors, 7, 211-213
- object glasses, 5, 445
- testing, 5, 452
- water-filled, 4, 194, 200

**Telluric acid, 1, 333****Tellurium, 1, 442-443**

- atomic,
  - heat, 5, 190; 7, 401
  - radius, 8, 326; 9, 502
  - refraction, 2, 541
  - volume, 7, 401
  - weight, 1, 500-508; 2, 325, 541; 5, 190
- discovery, 2, 316-317
- fluorine, reaction with liquid, 6, 425
- ionic radius, 9, 86
- mass spectrum, 8, 339
- sols, 2, 21
- specific heat, 2, 325; 5, 190; 6, 85-87

**Tellurous acid, 1, 333****Temperature,**

- absolute zero of, 10, 71-98

**adsorption,**

- charcoal, by, 6, 397-404
- low, at, 6, 104-119

**air and ground, 3, 275-280****arc, electric, of, 3, 88-90; 5, 236; 7, 237****Temperature—cont.**

- bacteria, effect of low, 5, 470-471
- biological effects, 4, 470-472
- biology at low, 4, 222
- blow lamp, 7, 237
- breaking stress and, 4, 267-270; 5, 462
- chemical affinity, and, 5, 465
- cohesion, effect on, 5, 472
- colour, and, 4, 261-263, 378; 5, 464; 6, 428; 7, 238
- compressibility, and, 5, 143-146
- critical, 2, 294-301; 3, 312-317; 6, 75
- crystal,
  - effect on, 1, 297
  - spacing, 7, 454
  - structure, 9, 258
- density measurement at low, 6, 1-9
- dielectric constant, 5, 462
- differences, sound from, 1, 107-110
- diffusion, and, 7, 476-479
- earth's interior, 1, 374
- elasticity, and, 8, 352-360
- electrical properties at low, 4, 517-548
  - measurement, 2, 342-352
- electrification at low, 6, 210-211
- evaporation, 6, 75; 7, 226
  - rate, 7, 494
- expansion coefficient at low, 6, 1-9
- explosion, 3, 380-386, 443, 449-450
  - 9, 466-476
- flame, 1, 432; 7, 237
- furnaces, of electric, 7, 239
- gas viscosity, 5, 248-252
- gases of, 8, 347
- granite, effect on, 8, 291-292
- gravity, and, 5, 311, 472
- helium at low, 6, 248-261
- high, 7, 16-35, 235-246; 8, 291-308
  - chemistry at, 3, 80-90
  - measurement, 3, 87-90; 5, 236-252; 7, 237
- hydrogen flame, 2, 148-149
- hysteresis and, 4, 545-547; 5, 461
- inflammation of, 4, 142
- interstellar, 10, 94
- lamp of, 7, 46
- light absorption and, 4, 378; 9, 431-432
- limestone effect on, 8, 291-292

**Temperature—*cont.***

- line-broadening and, 3, 443
- liquefaction, comparison of, 4, 472
- low, 3, 23; 5, 472–475
  - history, 5, 454–455
  - measurement, 3, 22–23; 4, 218–219; 10, 84–86
  - phosphorescence at, 5, 464
  - photography at, 4, 222; 5, 167–169, 465
  - properties at 5, 459–465; 6, 1–9
  - resistance at 4, 229–231
  - screening at, 5, 458
  - thermometer for, 5, 458
  - X-ray absorption at, 6, 104–119
- lowest,
  - 1891, 4, 160
  - 1895, 5, 213
- magnetism, 1, 195; 4, 140, 270–272; 5, 461–462
  - low, at 4, 517–548
- measurement, 5, 450–451; 7, 223–228
  - effusion, by, 3, 246–247
  - radiation by, 3, 87–90
  - transpiration by, 5, 247–252
- metal flow, 6, 7
- nadir, 6, 381–390
- nebula, of, 5, 416
- osmotic pressure, and, 7, 6–7
- permeability, and, 4, 542–545; 9, 443–445
- phosphorescence, and, 4, 375–378
- photochemistry, and, 7, 80–92
- photoelectric effect, and, 9, 431–432
- physiological effect, 5, 470–472
- polishing, 10, 250
- radiation, 3, 87–89
  - wavelength, 1, 46
- refractive index, 1, 299; 2, 136–139
- resistance, 2, 344, 351–352; 4, 518–535; 5, 320, 459–461; 9, 419–445
  - selenium, of, 3, 144
  - standard, 4, 426
  - theory, 5, 412
- rigidity, 8, 359–360
  - modulus, 4, 266–270
- rubber elasticity, 8, 255
- scale,
  - absolute, 6, 439

**Temperature—*cont.***

- scale—*cont.*
    - gas, 5, 202
    - Kelvin, 10, 71–72
    - platinum, 4, 522–524
    - thermoelectric, 5, 202
  - solubility, 3, 394
  - specific heat, 6, 83–85, 431, 8, 104–106
  - steel, effect on, 5, 447
  - sun, of, 1, 374, 432; 5, 236–239; 6, 381; 7, 237
  - surface tension, 10, 5
  - thermite process, of, 7, 237
  - thermionic emission, 7, 494
  - thermoelectric effect, 4, 535–541; 5, 461
  - viscosity, 2, 213; 5, 143–151; 6, 387–388; 7, 440
  - vitamins, effect of, 8, 375
  - X-ray diffraction, 9, 258
  - Young's modulus, 4, 266–270; 5, 464; 8, 352–355
- Tenacity of alloys, 6, 425–426**
- Tennis ball, 7, 104**
- Tensile strength, 2, 276**
- and temperature, 6, 425–426
- Tension,**
- electrical, 1, 365–369
  - magnetisation, and, 3, 18–20; 4, 137–140
  - stretched string and frequency, of, 2, 29–30
  - superconductivity, and, 9, 425
  - surface, 10, 1–14
- Terbium, 1, 357**
- Termination of polymerisation, 10, 265–268**
- Terpenes,**
- action on photographic plate, 5, 258–259
  - molecular refraction, 6, 156–162
  - nature, 6, 10
- Terpineol, 6, 12**
- nitrosochloride, 7, 202**
- Terrestrial,**
- electricity, 1, 340–347
  - evolution, 7, 16
  - magnetism, 1, 3, 9–12, 82, 435–441; 2, 96–101; 4, 425
  - heating by rotation in, 2, 11–12

**Terrestrial—*cont.***

- magneto-electric induction, 2, 58–67
- rotation, 1, 13–17
- structure, 7, 16

**Tertiary,**

- alcohols, 2, 485–487
- butyl alcohol, 8, 286

**Tesla coil, 4, 169**

- discharge in closed vessels, 4, 181–182
- lighting of lamp, 4, 179

**Test for,**

- aniline, 1, 570
- diamagnetism, 1, 66
- hydrazoic acid, 7, 197
- lithium, 1, 278
- optical flatness, 4, 242–247
- ozone, 1, 22

**Tetanus, 5, 419****Tetartohedrim, 7, 333****Tetrabromofluoresceine, 6, 99****Tetrabromodichlorofluoresceine, 6, 99****Tetrabromodinitrofluoresceine, 6, 99****Tetracarboxyanines, 10, 132, 138****Tetrachloroethane,**

- infrared transmission, 8, 285
- synthesis, 1, 142

**Tetrachloroethylene,**

- discovery, 9, 96
- synthesis, 1, 142
- viscosity, 5, 141–154

**Tetrachloropyridine, 8, 286****Tetraethyl silicate, 1, 331 332****Tetraethylammonium,**

- hydroxide, 1, 211–212
- iodide, 1, 211–212; 8, 288

**Tetragonal,**

- crystal angles, 7, 351
- elements, 7, 128
- symmetry, 7, 330–333

**Tetrahydroberberine, 7, 364–367****Tetrahydroparaquinanisol, 3, 371–372****Tetrahydroquinaldine, 6, 28–29**

- supercooling, 7, 121

**Tetrahydroquinoline, 8, 1****Tetrahydroxyquinoline, 3, 370****Tetraiododichlorofluoresceine, 6, 99****Tetraiodofluorescein, 6, 99****Tetramethyl glucose, 9, 53–54****Tetramethylammonium,**

- iodide, 2, 189; 8, 288

**Tetramethylammonium—*cont.***

- oleate, 8, 388–448

**Tetramethylenediamine, 2, 248****Tetrakaidekahedron, 7, 335****Tetrakis hexahedron, 4, 118****Tetrazole, 7, 203****Tetryl alcohol, 1, 479****Thalline, 3, 371–372****Thallium, 1, 442–444**

- actinium D, and, 8, 122
- atomic,
  - heat, 7, 401
  - refraction, 2, 541
  - volume, 7, 401
  - weight, 1, 500–508; 2, 325, 541
- bacteria, action on, 7, 86–92
- bromide, 1, 444
- chlorate, 1, 444
- chlorides, 1, 444
- chromate, 1, 444
- diamagnetism, 1, 444
- discovery, 1, 442–444, 509; 2, 316–318
- ferrocyanide, 1, 444
- iodide, 1, 444
- isotopes, 8, 457
- lead deposits, in, 2, 320
- occurrence, 1, 509–510
- oxide, 1, 444
- peroxide, 1, 444
- platino-chloride, 1, 444
- preparation, 1, 442–444
- properties, 1, 442–444
- proton bombardment, 9, 498
- radioactive, 8, 122
- resistance and temperature, 4, 524–527

**specific heat, 2, 325****spectrum, 1, 443; 2, 320–321****sulphide, 1, 444****superconductivity, 9, 424****thiocyanide, 1, 444****thorium D, and, 8, 122****trace in explosion, 3, 446–450****tree, 2, 338****ultraviolet spectrum, 3, 266****Zeeman effect, 6, 208****Thallous ion, radius, 9, 86****Theorem, Nernst, 10, 97****Theory,**

- absorption spectra, of, 7, 370

Theory—*cont.*

- acids, of, 1, 74-77
- aether, the, 1, 78; 3, 350-351; 5, 324-329, 564-567
  - vortex, 4, 394
- aggregation, of, 1, 78-83
- allotropy, of, 1, 58
- alloys, of, 10, 226
- atomic, 1, 19; 3, 122
  - Bohr's, 8, 42-45
  - Dalton's, 6, 24
  - history, 5, 555-556; 6, 90
  - isotopes, and, 8, 332
  - nuclear, 8, 130-135
- aurora borealis, of, 5, 414
- binocular vision, of, 4, 394
- birefringence, of, 3, 530-531
- black-body radiation, of, 7, 446
- de Broglie, 9, 206-213
- Brownian motion, of, 7, 180
- bubble formation in ice, of, 1, 252-255
- caloric, 4, 275; 5, 359-360; 6, 349-350
- capillary action, 3, 326
  - surfaces, 3, 337-341
- colloids, of, 9, 63-72
- cathode rays, of, 5, 103-104
- catalysis, of, 1, 158-163
- chemical affinity, of, 1, 136-139
- constitution, 2, 177-183
  - kinetics, 1, 18-21
- colour, 1, 219-226, 241-245
  - photography, 5, 125-134
  - vision, 4, 394; 5, 125-134
- combustion, 1, 158-163; 6, 301-313
- conductivity of metals, 5, 411-412
- contact electricity, 5, 563
- cosmogony, 10, 43
- crystals, 9, 79
- Debye-Huckel, 9, 410
- dew, 3, 268-270
- diffusion, 2, 38-44, 221-233
  - liquids, in, 2, 215
  - pump, 9, 241-244
- disintegration, 6, 275-286
- dispersion, 3, 240-247
- dissociation, 5, 334
- dyes, 5, 525-537
- dynamics, 4, 249
  - light and heat, of, 5, 324-355

Theory—*cont.*

- elasticity, 3, 60-62, 131-137
- electric current, 2, 107-112
  - discharges, 6, 167-180
  - induction, 1, 96-106
- electrical conduction, 1, 164-172; 5, 411-412; 6, 431-432
- electricity, 1, 29-33, 59, 173-176, 184-186, 237; 2, 372-382; 4, 154; 5, 554-555
  - electronic, 5, 551-569
- electrolytic dissociation, 6, 90-103
- electromagnetic, 8, 516-517
  - Faraday, and, 9, 106-107
- electrolysis, 5, 484-499
  - Faraday's, 8, 343-344
- electromagnetism, 3, 485; 4, 321; 5, 564
- electron mass, 5, 409
- emanation, 6, 154
- engine, 1, 182-183
- etherification, 1, 18-21, 76; 2, 211; 5, 487
- evaporation, 7, 493
- fits, 8, 513-514
- fluids, 2, 510 519
- fluorescence, 1, 495 496; 3, 250-254
- force, 1, 227-240
- freezing point depression, 7, 8
- glow discharge striations, 1, 279-281; 7, 36-45
- gravity, 1, 59, 71, 143 149; 2, 79, 372 382
  - relativity, 8, 102-103, 181 197
- gyroscope, 5, 184-185
- Hall effect, 5, 564
- heat, 1, 29-30, 42-48, 78, 196-201, 346; 2, 275-281
  - dynamical, 5, 324-355; 8, 103
- infrared absorption, 1, 463-466
- interference of light, 8, 517-518
- ionic, 6, 90-103
- isotopes, 8, 459-461
- kinetic,
  - development, 5, 362-363
  - gases, of, 3, 38-40, 122, 132-133, 136-137, 227-256; 5, 329-358; 7, 169-171; 8, 347
  - liquids of, 7, 169-171
  - spectra and, 8, 238
  - viscosity, of, 7, 169-171

Theory—*cont.*

- light, 1, 29, 42-48, 59, 257; 2, 7-12, 156-177; 3, 227-256, 454, 462
  - absorption, 1, 350-351, 385-389, 492-499; 2, 1-6
  - corpuscular, 8, 510-515; 9, 4-5
  - polarisation, 2, 273-274
  - propagation, 1, 346
  - refraction, 3, 239
  - scattering, 2, 261; 3, 248-250; 7, 97
  - velocity, 3, 240-247
  - wave, 1, 5-6, 42-48; 2, 123; 5, 278; 8, 510-515; 9, 4-5
- line spectra, 8, 108-109
- liquid helium, 10, 474-477
- lubrication, 7, 440
- magnetism, 1, 59-63, 68, 140-153, 184-186, 346, 523-528; 2, 101-107, 372-382; 4, 7-12, 127-141
  - crystals, of, 10, 142-147
  - molecular, 3, 281-290; 4, 515-516
  - quantum, 9, 88-92
- magneto-optical effect, 5, 177-188
- matter, 1, 78-83
- Maxwellian electric, 8, 213
- molar, 3, 327-328
- micellar, 9, 64-72
- molecular pump, 9, 237-241
- occlusion, 2, 49
- order-disorder, 10, 226
- osmosis, 7, 7-13
- oxyhaloid, 41, 45-46
- oxy-salts, 2, 205
- $\alpha$ -particle velocity, 8, 520
- phlogiston, 2, 282-291
- phosphorescence, 3, 245, 250-254
- photoelectric effect, 8, 109, 516; 9, 182-192
- photography, 4, 44-48
- piezoelectric effect, 10, 172-177
- preferential hydrogen combustion, 6, 301-313
- quantum, 7, 508-511; 8, 100-110, 223-226; 9, 365-385
- radiation, 3, 268-280; 8, 510-519; 9, 4-5
  - pressure, 6, 150

Theory—*cont.*

- radiation—*cont.*
  - quantum, 7, 446; 8, 510-519; 9, 4-5, 210-216
  - relativity, 9, 201-204
- radioactivity, 7, 154-163
- reaction mechanisms, 10, 384-403
- refraction, 8, 511-512
- refractive index, 2, 137-139; 3, 240-247
- relativity, 8, 100-110, 181-197
- scattered radiation, 8, 59-60
- shadows, 3, 463-464
- sound, 1, 29, 32-35, 454-465
- specific heat,
  - Einstein, 7, 233-234
  - quantum, 7, 446
- supersaturation, 3, 400
- surface tension, 8, 511, 10, 3-4
- thermionic emission, 7, 493
- thermomagnetic effect, 5, 564
- Thompson effect, 5, 564
- tides, 5, 278
- valency, 8, 115-119
- vision, 4, 339-340
- Voltaic pile, 2, 75-78
- volume, 7, 334-346
- vortex, 7, 438
- water, 6, 426-428
- wave, 1, 5-6, 42-48
  - light, of, 2, 123; 5, 278; 8, 510-515; 9, 4-5
  - sound, of, 2, 123
  - Young, and, 5, 278
- X-ray diffraction, 7, 345-347
  - Bragg, 7, 447-448
- X-rays, 5, 132-134; 7, 348; 9, 4-5
  - quantum, 7, 446
- Zeeman effect, 5, 267-268
- Thermal conductivity of metals, 6, 213
- decomposition of gases, 2, 149
- expansion,
  - crystals, of, 1, 297
  - structure, 8, 382
  - gases, of, 4, 105-106
  - refractive index, and, 1, 299
- insulation at low temperatures, 5, 465
- junction radiation detector, 4, 333, 341
- radiation detector, 4, 341

**Thermite process**, 7, 237

**Thermionic**,

current, 7, 495

emission, 5, 407; 7, 492-500

cooling by, 7, 495

gas constant from, 7, 498

in vacuo, 7, 492-493

temperature, and, 7, 494

theory, 7, 493

velocity, 7, 496-498

**Thermochemistry**, 3, 544

**Thermocouple**, 1, 180

iron-copper, 3, 22-23

platinum, 5, 240-241

temperature, and, 4, 535-541

limits, 7, 238

use at low, 3, 22-23

**Thermodynamics**, 5, 332

animal, 6, 361

cells, of, 6, 360-361

chemical, 2, 422

first law, 4, 275

Kelvin's work, 6, 348-360

magneto-, 6, 361-362

radiation, of, 6, 359

pressure, and, 6, 150

second law, 2, 420; 3, 36-37; 6, 354

third law, 10, 97

**Thermoelasticity**, 6, 62-63

**Thermoelectric effect**, 1, 113-114, 180,

235; 2, 77; 6, 354

discovery, 3, 270; 5, 64

measurement, 4, 536-537

neutral point, 4, 540

potentials, 4, 431

power, 4, 539

pyrometer, 2, 344; 3, 87

temperature, and, 4, 535-541; 5, 461

low, at, 4, 29

scale, 5, 202

thermometer, 5, 240-244

zinc blende, of, 9, 450

**Thermoluminescence**, 4, 507

alkali chlorides, of, 5, 37

radioactivity, and, 5, 513

rays, effect of, 4, 502

solid solutions, of, 5, 37

**Thermomagnetic effects**, 6, 362-363

theory, 5, 564

**Thermometer**,

air, 2, 343

**Thermometer—cont.**

blackened, 1, 42

charcoal, 6, 228-229

deep-sea, 8, 348

electrical limits, 7, 238

English glass, 5, 540

expansion, 7, 238

gas, 5, 202-212, 244-247; 7, 223-

228, 238; 10, 84-85

range of, 5, 237

glass for, 5, 445-446

hydrogen, 5, 450

Leslie, 6, 229

liquid, 2, 344

low-temperature, 5, 458

mercury-in-glass, 7, 238

mercury-in-silica, 7, 238

parametric, 10, 85-86

platinum,

expansion, 5, 240-243

resistance, 4, 522-524, 537; 5,

208-212, 240-247

resistance, 2, 342-352

limits, 7, 238

rhodium-platinum resistance, 5,

212

solid, 2, 344

specific heat, 5, 240-241

temperature limits, 7, 238

thermoelectric, 2, 344; 5, 240-245

**Thermometry**, 5, 450-451

high temperatures, at, 7, 238

low temperatures, at, 6, 433-435; 7,

223-225

**Thermopile**, 1, 305-308, 348; 4, 333;

8, 237

bismuth-silver, 9, 225

disadvantages, 3, 207

infrared detection, 9, 223, 225

invention, 1, 529-530; 3, 270-271

**Thermoscope**, charcoal, 8, 253-270

**Thickness**,

films, of.

limiting, 3, 234-237

measurement, 9, 40

mhoic effective, 4, 99-100

oil films, of, 4, 30-31

oxide layers, of, 3, 237-238

surface layer, of, 3, 319-324

**Thin films**, 9, 109-113

metal, of, 3, 239

Thin films—*cont.*

X-ray diffraction, 9, 37–47

Thin plates, colours, 3, 438–439

## Thinning of,

gold leaf, 1, 216

soap film, 3, 319–324

Thiocarbamides, 7, 60

Thiocarbocyanine, 10, 132–133

Thiocyanates, 1, 128

Thiocyanic acid, 1, 399

Thionines, 5, 533

Thionyl chloride, 1, 329

## Thiophene,

infrared transmission, 8, 288

spectrum, 7, 358

viscosity, 5, 141–154

## Thiophosgene,

infrared transmission, 8, 284

reaction with nickel carbonyl, 7, 143

Third law of thermodynamics, 10, 97

Thixotropy, 10, 150–171

and ultrasonics, 10, 160–164

Thompson (*see Kelvin*)

effect, prediction, 6, 354

theory, 5, 564

## Thoria, 7, 29

mantle, 6, 388–389

specific heat, 6, 85–87

Thorianite, 8, 452–453

Ceylon, 8, 125–134

helium in, 6, 260

Thorite, Ceylon, 8, 125, 134

## Thorium,

A, 6, 278; 8, 457

atomic,

heat, 7, 401

radius, 9, 502

refraction, 2, 541

spectrum, 3, 407–408; 8, 127

volume, 7, 401

weight, 1, 500–508; 2, 541; 8, 127–129

B, 6, 278; 8, 457

C, 6, 278

disintegration, 8, 133; 9, 10–12

half-life, 8, 457

 $\alpha$ -particle spectrum, 9, 412–418

catalysis by, 7, 102

D,

actinium D, and, 8, 122

half-life, 8, 457

Thorium—*cont.*D—*cont.*

thallium, and, 8, 122

decay, 7, 247

discovery, 2, 316–317

disintegration, 8, 451

emanation (*see Radon and Thoron*)

half-life, 6, 278; 8, 453, 457

ionium, and, 8, 120–128, 454

isotopes, 8, 457

lead from, 8, 124–126

occurrence, 6, 438

radioactivity, 5, 512–524

radiothorium, and, 8, 120

separation from radiothorium, 8, 451

series, 6, 278; 8, 453

haloes, 8, 111–112

sulphate, 3, 408

thorianite, in, 8, 125

thorite, in, 8, 125

uranium ratio in pitchblende, 8, 128

X, 7, 247

half-life, 6, 278; 8, 453

## Thoron, 8, 451

half-life, 6, 278; 8, 453, 457

inert gas, 7, 71

## Three,

circle goniometry, 7, 352

colour method, 4, 479

dimensional grating, 7, 345

lens condenser, 4, 185

## Thunder, 1, 334–347

## Thuringian glass, 5, 446

## Thyroid,

gland, 10, 336, 340–344

hormone (*see Thyroxine*)

## Thyroxine, 10, 341–344

metamorphosis, 10, 341

molecular structure, 10, 342

synthesis, 10, 342

## Tidal,

bores, 7, 341

motion, 4, 350

## Tides, 1, 375; 4, 248; 7, 341

calculation, 6, 372

Young's work, 5, 278

## Timbre, 2, 24

## Time,

concept of, 1, 227

divisibility, 3, 228



**Time—cont.**

- force, and, 1, 228
- gravitation, and, 1, 60
- imaginary, 8, 184
- lag in magnetisation, 4, 139
- magnetism, and, 1, 71
- pressure recorder, 8, 466–467
- relation to length and mass, 4, 429
- relaxation, 9, 429–445
- rigidity, and, 9, 168
- space relations, 8, 184–197

**Tin,**

- absorption of X-rays, 8, 46–54
- abundance, 10, 272
- action current, 5, 426–427
  - bacteria, on, 7, 86–92
  - photographic plate, on, 2, 257
- allotropy and specific heat, 5, 192
- atomic,
  - heat, 5, 190; 7, 401
  - radius, 8, 326
  - refraction, 2, 138, 541
  - spectrum, 3, 134
  - volume, 7, 401
  - weight, 1, 500–508, 535; 2, 325, 541; 5, 190; 9, 7
- band spectrum, 3, 259
- bell-metal, in, 9, 214
- bismuth alloys, 5, 191
- boiling point, 7, 237
- breaking stress, 4, 269
- bronzes, in, 9, 214
- chloride,
  - active nitrogen, and, 7, 310
  - electrolysis, and, 9, 401
- coinage, in, 9, 214
- copper alloy, 9, 2
- crystal structure, 8, 320
- effect on mutual induction, 3, 304
- elasticity, 4, 270
  - and temperature, 5, 464
- electrochemical equivalent, 2, 75; 9, 401
- emissivity, 8, 290
- etching, 4, 123
- ethyl, 1, 139
- gold alloy, 9, 424–425
- gun-metal, in, 9, 214
- low temperature resistance, 4, 230
- mass spectrum, 8, 339
- melting point, 7, 237

**Tin—cont.**

- mirror-metal in, 9, 214
- optical activity, 6, 34
- oscillation damping, 8, 358
- rate of discharge, 6, 21
- rays, 7, 161–163
- resistance and temperature, 4, 524–527
- rigidity, 8, 360
- screening by, 4, 100
- silver alloys, 9, 424–425
- specific heat, 2, 325; 5, 190
  - and allotropy, 5, 192
- speculum, on, 9, 214
- stone, colloidal, 1, 396
- superconductivity, 9, 424–445
- surface tension of liquid, 4, 118
- tetraethyl, 1, 536
- thermal conductivity, 6, 213
- trace in explosion, 3, 445–450
- tree, 2, 339
- ultraviolet spectrum, 3, 259
- Young's modulus, 8, 354–355

**Tinfoil,**

- rate of discharge, 6, 21
- reflection of Hertz waves, 4, 346

**Tincture of guaiacum, 1, 282****Tinned iron, 6, 218****Tissue,**

- fatty, 10, 227–243
- protein, 10, 414

**Titanic acid, 1, 333**

- colloidal, 2, 216–217

**Titanium,**

- abundance, 10, 272
- aluminium alloy, 4, 525–527
- argon, action on, 4, 406
- atomic,
  - heat, 7, 401
  - radius, 8, 326
  - refraction, 2, 541
  - volume, 7, 401
  - weight, 1, 500–508; 2, 501, 541
- dioxide, crystal structure, 7, 336
- discovery, 2, 131, 316–317
- oxide, 8, 299–300
- quartz, in, 9, 166
- tetrachloride, 2, 503

**Toasting, 7, 413****Tobacco,**

- mosaic virus, 10, 220–223

**Tobacco—cont.****mosaic virus—cont.**

- constitution, 10, 220
- molecular weight, 10, 220
- streaming birefringence, 10, 220–222

**X-ray diffraction, 10, 223**

plant, effect of heavy water, 10, 20

rubidium in, 2, 320

smoke,

Brownian motion, 7, 165

light scattering, 3, 431

**Toepler,**

machine, 3, 467

pump, 9, 285

**Toluene,**

chlorination, 3, 166

coal, from, 1, 399

tar, 2, 184–185; 9, 100

1 ton coal, 3, 365–366

discovery, 9, 100

dyes, 3, 368

infrared transmission, 8, 285

petroleum from, 9, 104

sulphonation, 3, 373

sulphonyl,

chlorides, 3, 374

diazo-compound, 7, 200

synthesis, 2, 145

viscosity, 5, 142–154

**Toluidine, 1, 571; 2, 146, 185**

infrared transmission, 8, 287

**Tonca beans, 3, 372; 6, 12****Tones,**

combination, 4, 385–393; 10, 404–413

difference, 4, 385–393

**Tooth, kittens, 4, 186****Toothed-wheel, 2, 435–437****Top spin, 7, 106****Topaz, 7, 54**

polariscope, in, 4, 187

ultraviolet absorption, 1, 430–431

**Tops, 3, 136****Torpedo fish, 9, 94****Torque, 6, 369**

optical, 3, 516–539

**Torreclian vacuum, 9, 235****Torsion, 1, 16**

balance, 1, 64–73; 10, 101–103

Boy's, 4, 355–367

**Torsion—cont.****balance—cont.**

Coulomb's, 1, 185; 4, 352

hydrogen use of, 4, 370

measurement of gravity, 4, 354

diameter, and, 3, 561

quartz fibre and loading, of, 4, 371

superconductivity, and, 9, 425

viscous sample, of, 6, 69–73

**Tortoise, muscle response, 5, 418****Tortoiseshell,**

butterfly, 9, 261

phosphorescence, 4, 377; 5, 464

**Total internal reflection, 1, 132–133**

microwaves, of, 5, 18

sound, of, 9, 286–287

**Toughness, 8, 361–362****Touraco, 4, 236–246****Tourmaline, 4, 509**

birefringence, 2, 168–169

dichroism, 2, 271

magnetism, 1, 80, 193–195

microwave birefringence, 5, 22

optical properties, 1, 5–6

polarisation of light, 2, 168–169

polariscope, 2, 271

polariser, 3, 519

pyroelectricity, 4, 124

zoned crystals, 4, 53

**Tower Bridge, 5, 449****Town gas, 7, 419****Toxicity,**

hydrogen fluoride, of, 5, 88

ozone, of, 1, 23

phosphorous, of, 1, 38

**Toxins, 10, 414****Transatlantic radio, 7, 280–281****Transducer quartz, 9, 283–285****Transfer,**

energy in spectra, of, 8, 241–242

tubes, 7, 64–66

**Transference, electrolytic, 5, 489****Transformation, mathematical, 8, 187****Transformer,**

Hedgehog, 4, 403

high potential, 4, 401

liquid oxygen core, 5, 5–10

loss, 4, 136, 512–513

oil, 9, 285–287

properties, 4, 413–419

simple, 1, 173–176; 3, 310–304

- Transitions,  
   electronic, 9, 225  
   liquid crystals, of, 9, 512-515, 536  
   rotational, 9, 225-229  
   vibrational, 9, 225-229  
 Translational,  
   energy, 5, 329-350  
     argon, of, 4, 408  
     diatomic molecule, of, 8, 104-105  
   velocity, 4, 144  
     hydrogen, of, 5, 363  
 Transmission,  
   electricity, of, 6, 375-376  
   effect of capacitance, 1, 99-105  
   gratings, 10, 203  
   infrared radiation, 8, 253-290  
     crystals, by, 1, 297  
     gases, by, 1, 305-308  
   light by gold leaf, 1, 215-218, 249-251  
   lines, 1, 99-105  
     effect of pulse, 4, 421  
   reflection correction, 8, 275-283  
   sound, 4, 248; 8, 309  
   ultraviolet by quartz, 1, 89  
 Transmitter, spark-gap, 4, 18-19  
 Transmutation of elements, 7, 248; 9, 20-24, 495-499; 10, 22-27  
   heavy, 10, 252-257  
 Transparency, 5, 253-256  
   and diathermaney, 1, 43  
 Transparent negative, 4, 41  
 Transpiration,  
   balance, 5, 250-252  
   method, 9, 169  
   pyrometry, 5, 247-252  
   rates of, 2, 40-44, 221-233  
   water from plants, of, 5, 372-373  
 Transport numbers, 5, 490-491; 9, 408-409  
 Transuranium elements, 10, 254-256  
 Transversal contraction, 3, 60-62  
 Treacle,  
   effect on carbon, 8, 295  
   viscosity, 6, 67  
 Trees, 6, 361  
 Trevelyan's rockers, 3, 2  
 Triacetin, 8, 287  
 Triaminobenzene, 1, 543-544  
 Triaxial crystals, 5, 541-550  
 Triazens, 7, 203  
 Triazo-group, 7, 195  
 Triazoacetic,  
   acid, 7, 198  
   azide, 7, 202  
   ester, 8, 288  
 Triazoacetone, 7, 202  
 Triazoantipyrène, 7, 202  
 Triazocamphor, 7, 202  
 Triazoethyl,  
   alcohol, 7, 198  
   infrared transmission, 8, 288  
   acetate, 8, 288  
 Triazoethylamine, 7, 204  
 Triazopropionic acid, 7, 198  
 Triboluminescence, 4, 507; 9, 222  
 Tricarbocyanines, 10, 132, 137-138  
 Trichloroacetic acid,  
   infrared transmission, 8, 287  
   preparation, 1, 142, 477  
   reaction with potassium amalgam, 1, 477  
 Trichlorohydrin, 8, 286  
 Trichlorosilane, 2, 386-387  
 Triclinic,  
   crystal angles, 1, 351  
   symmetry, 7, 330-333  
 Triethoxy aluminium, 2, 499  
 Triethoxymethane, 2, 386  
 Triethoxysilane, 2, 386  
 Triethyl,  
   aluminium, 1, 535-538  
   dimerisation, 1, 537-538  
   bismuth, 1, 536  
   phosphate, 1, 332  
 Triethylamine, 1, 208, 211-212  
   formula, 1, 449-451; 2, 248  
   infrared transmission, 8, 287  
   molecular structure, 1, 403  
   oleate, 8, 388-448  
 Triethylarsine, 1, 209  
   formula, 1, 536  
 Triethylphosphine, 1, 209, 330  
   oxide, 1, 330  
 Triethylrosaniline, 3, 34  
 Triethylstilbine, 1, 209  
 Trigger tube, Zehnder, 4, 332, 341  
 Triglucon, 9, 60-61  
 Trigonal,  
   bipyramid, 7, 339  
   crystal angles, 7, 351

**Trigonal—cont.**

- symmetry, 7, 330–333
- trapezohedra, 7, 339

**Trihydroxyanthraquinone, 3, 172****Trilobite, 4, 333****Trimethyl,**

- aluminium, 1, 535–538
- dimersation, 1, 538
- carbinol, 5, 142–154
- cellulose, 9, 259
- glucose, 9, 53–54

**Trimethylamine, 2, 186; 3, 29–30**

- infrared transmission, 8, 287
- sugar beet, from, 3, 31

**Trimethylethylene, 5, 141–154****Trimethylrosaniline, 2, 188****Triphenylamine, 2, 186****Triphenylglyoxalin, 9, 219****Triphenylmethane, phosphorescence, 4, 377****Triphenylmethyl radical, 9, 20****Triphenylrosaniline, 2, 187****Triple bonds, refraction, 6, 162****Triplet, Zeeman, 5, 267–276****Trisodium phosphate, 1, 332****Tritium, 10, 26–27**

- atomic weight, 10, 26
- discovery, 10, 26

**Trogons, 4, 237****Trombone, 8, 207****Tropeolines, 3, 367****Trumpet, 5, 476; 8, 207****Trypsin, 10, 414****Tube,**

- Coolidge, 7, 488
- Crookes', 4, 490
- flow through, 6, 68
- friction of water in, 4, 2–3
- Kundt's, 9, 304–311
- vacuum transfer, 7, 64–66

**Tuberculosis, oil of, 6, 11****Tungsten,**

- abundance, 10, 272
- atomic,
  - heat, 7, 401
  - refraction, 2, 541
  - volume, 7, 401
  - weight, 1, 500–508; 2, 325, 541
- boride, 9, 424
- carbide, 9, 424
- cathode, 7, 488

**Tungsten—cont.**

- discovery, 2, 316–317
- heat of electron emission, 7, 496
- melting point, 7, 237
- nitride, 9, 424
- rigidity, 8, 360
- silicide, 9, 424
- specific heat, 2, 325
- steel, 8, 296

- magnetism, 10, 458
- thermionic emission, 7, 494–500

**Tungstic acid, 1, 333**

- colloidal, 2, 216–217

**Tuning,**

- damping, and, 4, 325–326
- fork,
  - directivity, 5, 481
  - electric, 3, 2, 522; 4, 436–437
- pendulum, of, 8, 199–201

**Turacin, 4, 235–240**

- caustic soda, action of, 4, 238
- colloidal properties, 4, 239
- composition, 4, 240
- heat, effect of, 4, 239
- spectrum, 4, 236
- sulphuric acid, action of, 4, 239
- water in, 4, 239

**Turacoporphyrin, 4, 239–240****Turacoverdin, 4, 238–239**

- spectrum, 4, 238–239

**Turacus, 4, 236–240****Turkey red, 2, 191****Turpentine, 1, 37, 56, 452**

- analysis, 2, 478–479
- film, 8, 1
- glass, 4, 263
- infrared transmission, 8, 288
- optical activity, 3, 516; 7, 380
- phosphorous glow, and, 3, 209; 4, 15; 9, 27
- properties, 2, 478–479
- ultraviolet absorption, 1, 430–431

**Tissue, burning by radium, 5, 512****Twinning, crystal, 3, 493; 7, 340****Two-,**

- circle goniometry, 7, 352
- cylinder pump, 9, 234
- stage heating, 3, 377

**Tympanum, 1, 246****Tyndall, 4, 273–281**

**Tyndall—cont.**

- book on,
  - heat, 4, 275
  - sound, 4, 278
- effect, 8, 308–309
- Faraday, and, 2, 53
- work on,
  - absorption by gases, 4, 275
  - heat radiation, 4, 275–278
  - ice flowers, 4, 274
  - regelation, 4, 274
  - light scattering, 4, 280–281
  - origin of life, 4, 281
  - radiation and emission, 4, 275
  - sensitive flames, 4, 278
  - smoke jets, 4, 278–279
  - sound, 4, 278–280
  - sounding of gases, 4, 275
  - water jets, 4, 273–274

**Typhoid, 6, 437**

- virus, 2, 305

**Tyrian purple, 9, 103; 10, 339****Tyrosine, 10, 337–340****U****Ultra-atomic matter, 5, 556–558****Ultracentrifuge, 9, 293****Ultrafiltration, of,**

- colloids, 9, 64–68
- soap solutions, 9, 64–68

**Ultramarine, 9, 164****Ultramicroscope, 9, 70****Ultrasonics, 9, 281–296**

- anomalous movement, 9, 291–292
- biological effects, 9, 292–296
- boiling by, 9, 291
- critical angle, 9, 286–287
- flocculation by, 9, 292
- frequencies, 9, 282
- intensity measurement, 9, 289
- oil emulsification by, 9, 292
- properties, 9, 289–296
- radiation pressure, 9, 288–289
- reflection, 9, 285–289
- refraction, 9, 286
- stationary waves, 9, 285–289
- thixotropy, and, 10, 160–164
- total internal reflection, 9, 286–287

**Ultraviolet,**

- cell, 1, 429–430; 3, 510–511
- far-, 7, 487–491
- fluorescence, 7, 206
- light, 1, 88–89, 319–326, 427–434
  - absorption by,
    - altitude, at, 3, 436
    - atmosphere, 1, 89
    - coal-gas flame from, 1, 427–428
    - electric discharge, from, 1, 428
    - eye, 3, 264
    - gases, 1, 430–431
    - glass, 1, 88–89; 7, 213
    - liquids, 1, 430–431
    - sodium chloride, 1, 429–430
    - solids, 1, 430–431
  - bacteria, action on, 7, 84–92
  - cloud formation, 6, 64
  - coloration of glass, 9, 164
  - discharge of bodies, 4, 54
  - emission from lime-light, 1, 428
  - measurement, 1, 319–326
  - opacity of glass, 1, 88–89; 7, 213
  - photoelectric effect, 9, 182–192
  - photosynthesis, in, 9, 194
  - physiological effects, 7, 488
  - properties, 4, 502
  - reflection from metals, 1, 431
  - rickets, and, 8, 375
  - scattering, 7, 213
    - atmosphere, by, 2, 13–21
    - suspended sulphur, by, 2, 19–20
  - sparks, effect on, 4, 327–330
  - sun, from, 1, 428; 2, 13–21
  - transmission by,
    - quartz, 1, 89,
    - water, 1, 429
  - wavelengths, 9, 224
  - X-rays, and, 4, 508
- photography, 7, 205–222
  - of moon, 7, 214–217
- spectra, 1, 427–434
  - elements, of, 3, 257–267
  - metals, of, 1, 431–434
  - stars, of, 1, 433–434; 8, 316
- spectroscopy, 7, 355–370
- spectrum, 1, 89
  - mercury, of, 7, 379
  - sun, of, 3, 257, 260–262

Ultraviolet—*cont.*

telescope mirrors, 7, 211–213

Uncertainty principle, 9, 365–385  
and isotope effects, 10, 49–57

## Uniaxial,

crystals, 1, 298–304

magne-crystals, 9, 140

Uniform motion of the aether, 4, 195

Unimolecular reaction, 7, 248

Unit cell, 7, 330

## Units,

absolute, 4, 427–430

C.G.S. and M.K.S., 3, 92

electrical, 3, 311

system, 4, 427–430

## Universe,

entropy in, 6, 55

evolution, 8, 32

geocentric, 8, 101

mass, 6, 289

Unobservables, 10, 301–331

## Unsaturated,

hydrocarbons, 5, 141–154

molecules, 1, 565–568

Unsaturation and colour, 9, 18–19

Unstable atoms, 6, 275–286

Upper air, 6, 436

## Uranium VI,

A, 8, 457

actinium ratio, 6, 280

atomic,

heat, 7, 401

number, 8, 132

radius, 9, 502

refraction, 2, 541

volume, 7, 401

weight, 1, 500–508; 2, 501, 541;  
8, 129

discovery, 2, 131, 316–317

electrodes, 7, 403

glass, 1, 310; 3, 50, 252; 4, 507

half-life, 6, 278; 8, 520

I, half-life, 8, 453, 457

II, half-life, 8, 453, 457

helium from, 9, 312–313

ionium ratio in pitchblende, 8, 128

isotopes, 8, 452–454, 457; 10, 255–  
256

lead from, 8, 124–126

minerals, 6, 52

neutron bombardment, 10, 254–256

Uranium VI—*cont.*

nitrate,

colour and temperature, 4, 261; 5,  
464; 6, 428

low temperature,

electrification, 6, 211

phenomena, 5, 465

photocell, 7, 82–83

rate of discharge, 6, 21

triboluminescence, 4, 507

peroxide, 1, 87–88

potassium sulphate, 5, 508–524

proton bombardment, 9, 498

radioactivity, 5, 78–80, 508–524

radium from, 7, 253

radium ratio, 6, 280; 7, 253

rays, emission of, 4, 109

salts,

fluorescence, 1, 88

radioluminescence, 6, 41

scattering of  $\alpha$ -particles, 9, 74–76

series, 6, 278; 8, 119

haloes, 8, 111–112

tartrate, photoelectric effect, 3, 10

thorianite, in, 8, 125

thorite, in, 8, 125

thorium ratio, 8, 128

X, 7, 263–265

disintegration, 9, 11

 $\beta$ -emission, 7, 504

half-life, 6, 278; 8, 453, 457

Uranus, orbit, 8, 226

## Urea,

density, 6, 6

derivatives, 7, 383

expansion, 6, 6

infrared transmission, 8, 287

nitrogen from, 4, 398

phosphorescence, 4, 374

silicon, 7, 60

synthesis, 1, 273, 476

Wohler's, 1, 270

Urethane, 4, 377

Uric acid, 1, 303

Utilisation of sun's energy, 6, 361

Utricular state, 6, 222

## V

Vaccination, 2, 303; 9, 295–296

- Vacuoles, food**, 8, 31
- Vacuum**,  
   animals in, 9, 233  
   calorimeter, 5, 364  
   charcoal, 6, 106, 113, 215, 393-404  
     conductivity of, 6, 417-421  
   chemistry, 6, 219-226  
   dielectric constant, 1, 32  
   distillation, 9, 233  
   electrical discharge, 1, 32  
   globe, specific gravity, 4, 473  
   high, 3, 406; 4, 226-227; 5, 285, 320;  
     6, 248-261  
   production, 9, 232-244  
   soap films in, 8, 6-22  
   Torricellian, 9, 235  
   transfer tubes, 7, 64-66  
   transmission of heat by, 2, 275-281  
   tube,  
     detector, 4, 332, 341  
     resistance, 3, 113-115  
   vessels, 4, 223-229, 458-460; 5, 364-  
     365; 7, 385-401  
     design, 5, 161-166  
     discovery, 5, 455  
     metallic, 6, 218, 404-405; 7, 64-  
       66  
     silvering, 4, 225; 5, 166
- Valency**, 1, 549-554; 2, 177-183, 542;  
   6, 24-25; 8, 327-328  
   atomic, 8, 560-562  
   definition, 9, 107  
   electrons, 8, 131  
   elements, of, 2, 325  
   theory, 7, 334-336  
     electronic, 8, 115-119  
   volume, 7, 337; 8, 323
- Valentinite**, 8, 381-382
- Valeriana officinalis**, 1, 275
- Valeric acid**, 1, 274-275, 479  
   formula, 1, 546-547  
   infrared transmission, 8, 287
- Valeronitrile**, 8, 288
- Valve oscillator**, 9, 282
- Van der Graaf generator**, 9, 498
- Van der Waals equation**, 5, 202-203
- Van't Hoff and Le Bel's hypothesis**, 5,  
   195  
   *i* factor, 5, 495
- Vanadates**, 2, 124-130, 502
- Vanadic acid**, 1, 333; 2, 502-503
- Vanadinite**, 2, 124, 127, 500
- Vanadite**, 2, 127
- Vanadium**, 2, 124-130, 500-509  
   abundance, 10, 272  
   atomic,  
     heat, 7, 401  
     refraction, 2, 138, 541  
     volume, 7, 401  
     weight, 1, 500-508; 2, 126, 128-  
       130, 501, 541  
   catalysis of oxidation, 2, 506-509  
   chemical properties, 2, 124-130,  
     505-509  
   chloride, 2, 126, 130  
   dioxide, 2, 127-129  
   discovery, 2, 124, 131, 316-317, 500  
   dyeing, use in, 2, 505-509  
   filament, 7, 47  
   iron, in, 2, 124  
   melting-point, 7, 47  
   nitride, 2, 130  
   oxides, 1, 126-129, 505  
     formulae, 2, 127-128, 131  
   oxychloride, 2, 128, 503  
   pentoxide, 2, 128-131  
     occurrence, 2, 124-126, 500-501  
     rheopexy, 10, 158-159, 163-164  
     streaming birefringence, 10, 165-  
       167, 222  
     thixotropy, 10, 151, 158-159  
     tactoids, 10, 167-170  
   photography, 2, 505  
   physiological effects, 2, 503-504  
   test, 2, 124  
   tetroxide, 2, 128-131  
   trioxide, 2, 128-129; 7, 47
- Vanadous acid**, 1, 333
- Vane pump**, 9, 237
- Vanilla**, 3, 372
- Vanillin**, 6, 11-13  
   formula, 3, 372  
   occurrence, 3, 372  
   production, 3, 372
- Vanillon**, 3, 372
- Vaporisation of**,  
   mercury, 2, 55-56  
   metals, 2, 56  
   solids, 2, 294
- Vapour**,  
   current indicator, 7, 12  
   pressure, 2, 402

**Vapour—*cont.*****pressure—*cont.***

- colloids, of, 9, 64–67
- comparison, 4, 472
- equilibrium, and, 7, 8
- evaporation rate, and, 7, 494
- freezing-point, and, 7, 8–9
- mercury, of, 4, 227
- salt hydrates, of, 2, 526–527
- soap solutions, of, 9, 64–67
- solutions, of, 2, 526–527; 7, 9–15
- theory of osmosis, 7, 7–13

**supersaturation, 6, 62****Vapours and gases, 2, 49**

- absorption on charcoal, 6, 105–106

**Variation,**

- magnetic, 1, 72–73, 82, 435–441
- spectral, 8, 370–373

**Varley machine, 3, 467****Varnishes, 9, 248****Vaseline, 6, 11****Vats, dyeing, 2, 276; 9, 21****Vegetable matter, 4, 375****Vellum, 1, 395****Velocity,**

- adsorption on charcoal, of, 6, 251–254

- aether, of, 8, 101, 181–197

- contraction and, 8, 182–184

- distribution, 5, 353–358, 7, 497–498, 8, 239

- earth in aether, of, 4, 196

- electricity, of, 1, 99–105, 2, 437–438

- electron emission, of, 7, 496–498

- electrons ejected by X-rays, of, 8, 54–55, 57, 61

- explosion wave, of, 6, 301

- flame, 4, 142–149; 6, 300, 7, 409; 8, 469; 9, 467–494

- group, 9, 207

- hydrogen escape, 5, 470

- ions, 6, 185–186

- electric field, and, 8, 179–180

- pressure, and, 8, 179–180

- light, of, 1, 241; 2, 7–12, 381, 435–438, 477; 4, 224

- astronomical determination, 2, 435

- colour, and, 3, 240

- crystals, in, 5, 541–550

- flowing water, in, 4, 198

- media, in, 3, 239

**Velocity—*cont.*****light, of—*cont.***

- Michelson's determination, 4, 202
- refractive index, and, 3, 239

- revolving-mirror method, 2, 437–438

- theory, 3, 240–247

- toothed-wheel determination, 2, 435–437

- water, in, 2, 10

- liquids, critical of, 3, 298–299

- neutrons, of, 9, 416

- $\alpha$ -particles, of, 7, 502–503

- half-life, and, 8, 521

- theory, 8, 520

- $\beta$ -particles, of, 5, 516–520; 7, 503–504

- positive rays, of, 6, 314–344

- resistance and, 4, 429

- soap jets, of, 8, 423–433

- sound, of, 2, 413

- measurement, 9, 305

- translational of hydrogen, of, 5, 363

**Ventral segments, 2, 22****Venturi principle, 7, 432–436****Venus,**

- flower basket, 7, 63

- motion, 8, 185

- orbit, 8, 191, 226

- velocity, 8, 190–191

**Vermiline,**

- from 1 ton coal, 3, 365–366

- scarlets, 3, 368

**Vermillion,**

- allotropy, 1, 37

- colour and temperature, 5, 464; 6, 428

**Vessels,**

- for fluorine preparation, 5, 88

- vacuum (*see Vacuum vessels*)

**Vesuvius, 9, 95****Vibrating,**

- rod, 2, 24

- spring, 1, 372

- string,

- density, 2, 28

- diameter, 2, 29

- length, 2, 28–29

**Vibrational,**

- energy, 5, 335–358

- of diatomic molecules, 8, 104–105



**Vibrational—*cont.***

- excitation in flames, 8, 468–469
- modes of strings, 2, 23
- transitions, 9, 225–229

**Vibrations, 8, 198–211**

- atoms, frequencies, of, 7, 509–511
- brass,
  - instruments, 8, 205–207
  - in crystals, 7, 454
- compound, 8, 205
- coupled, 8, 198–224
  - pendulums, 8, 202–205
- damping, 4, 388
- demonstrations, 9, 297–311
- electrical, 8, 198–211
- flames, 4, 143–144; 6, 300
- forced, 5, 278; 8, 198–211
- heat conduction, and, 1, 109
- hysteresis, effect on, 4, 136–137
- mechanical, 8, 198–211
- molecules, 3, 122; 9, 227–228
  - in crystals, 4, 115
- monochord, 8, 207–210
- musical instruments, 8, 198–211
- nucleus, 9, 12–13
- phase of, 1, 247–248
- plates, 9, 298–304
- strings, 2, 22–30; 8, 207
- temperatures, from bodies of different, 1, 107–110
- traces of, 8, 204–211
- traffic, 4, 369–370
- violin, 8, 211
- water-drop, 3, 331

**Vibrator, Hertz, 4, 325****Victoria blue, 3, 368****Villari,**

- critical point, 4, 10
- value, 3, 18–20
- effect, 4, 11

**Vinyl,**

- alcohol, 2, 199
  - infrared transmission, 8, 286
- chloride, 2, 199,
- ether, 1, 272

**Vinylamine, 2, 199; 7, 204****Vinyltriamine, 1, 544**

- molecular structure, 1, 558–559

**Viola, 9, 115****Violaxanthin,**

- chromatography, 10, 231

**Violaxanthin—*cont.***

- occurrence, 10, 234
- spectrum, 10, 232

**Violerythrin, 10, 236****Violet,**

- artificial, 6, 11–12
- cornflower, 9, 115
- Impériale, 2, 188
- roots of, 6, 12

**Violin, 3, 1; 8, 207–211, 369**

- bow, 1, 246–248
- effect of flames, 2, 35–36
- vibration curves, 8, 210–211

**Violincello, 8, 211****Viridine, 1, 400****Virus, 2, 303**

- acuba, 10, 223
- effect of ultrasonics, 9, 295
- tobacco mosaic, 10, 220–221

**Vis a tergo, 6, 288****vitalis, 9, 199****viva, 1, 270–276, 371–372; 9, 97****Viscometer, 5, 136–140**

- capillary, 9, 169
- Comette's 9, 170
- oscillating-disc, 9, 169–170

**Viscosity,**

- acids, 5, 135–154
- air, 6, 387–388
- alcohols, 5, 135–154
- aldehydes, 5, 136–154
- aliphatic hydrocarbons, 5, 141–149
- anhydrides, 5, 142–154
- argon, 6, 454–455
- aromatic hydrocarbons, 5, 142–154
- blood, 9, 170
- bromides, 5, 141–154
- bromine, 5, 141–148
- Brownian motion, and, 7, 165
- chemical constitution, and, 5, 135–154
  - reaction, 7, 196
- chloride, 5, 141–154
- coefficient, definition, 5, 136–140
- colloids, 9, 169
- critical velocity, 3, 298–299
- demonstration, 3, 294
- eddy, 5, 220–232
- esters, 5, 135–154
- ethers, 5, 143–154
- gases, 2, 219–221; 3, 256; 7, 170

**Viscosity—*cont*****gases—*cont.***

- measurement, 5, 249–252
- soap films, and, 8, 443–448
- temperature, and, 5, 248–252

helium, 4, 454–455

high, 6, 67–73

homologues, 5, 125

hydrodynamics, 7, 431–432

iodides, 5, 141–154

ketones, 5, 136–154

kinetic, 7, 439

kinetic theory, 7, 170

liquids, 2, 211–213, 3, 290–299, 5, 135–154

surface, 3, 318

measurement, 4, 454–455, 5, 136–140, 6, 67–73, 9, 167

mercury vapour, 7, 388

nitrogen dioxide, 5, 141–149

paraffins, 5, 141–154

pressure, 3, 143–144

relative, 9, 168

saponin solution, 3, 318

serum, 9, 170

shear speed, 9, 170–181

soap solutions, 8, 390–391

sulphur compounds, 5, 141–154

surface, 4, 35–37

suspensions, 9, 179

temperature, 2, 213, 5, 143–151, 6, 387–388, 7, 440

water, 5, 141–149, 9, 168

**Viscous,**

beam, 6, 71–73

sample, torsion 6, 69–73

**Visible**

light 1, 427

photoelectric effect, 9, 182–192

wavelengths, 9, 224

spectrum of,

mercury, 7, 375–378

metals, 1, 431–434

stars, 1, 433–434

spectroscopy, 3, 63–79, 121–135

**Vision,**

binocular, 5, 435–436

theory of, 4, 394

colour,

range, 3, 257

theory of, 4, 394, 5, 125–134

**Vision—*cont***

recurrent, 5, 345–436

Vital force, 1, 270–276, 371–372, 9, 97

Vitality at low temperatures, 6, 437

Vitamin A, 8, 374–377

air, effect of, 8, 375

butter, in, 8, 375, 10, 239–243

carotene, and, 8, 375–376, 10, 237–243

cod-liver oil, in, 8, 375

deficiency, 8, 375–376, 10, 237

milk, in, 10, 239

occurrence, 8, 375–376

photosynthesis, and, 8, 375

potency, 8, 374–375

properties, 10, 237–238

rats, effect on, 8, 374–375

spectrum, 10, 238

structure, 10, 238

test, 10, 238

xanthophyll, and, 8, 375–376

Vitamin B, 8, 374–377

air, effect of, 8, 375

deficiency, 8, 375

heat, effect of, 8, 375

occurrence, 8, 376

origin, 8, 376

potency, 8, 374

rats, effect on, 8, 374

yeast, in, 8, 376

Vitamin C, 8, 374–377

air, effect of, 8, 375

deficiency, 8, 375

heat, effect of, 8, 375

occurrence, 8, 376

potency, 8, 374

provitamin, 8, 376

Vitamins, 8, 374–377

air, effect of, 8, 375

animals, and, 8, 376

crystal structure, 9, 461

deficiency, 8, 375–376

heat, effect of, 8, 375

hydrolysis, 8, 375

milk, in, 8, 376

occurrence, 8, 375–376

potency, 8, 374–375

**Vitreous,**

electricity, 5, 51, 56

humour, 1, 305

Volatility, 2, 398–404

- Volcanic,**  
 lime, 9, 96  
 phenomena, 6, 102  
**Volt, definition,** 3, 92  
**Volta-electric induction,** 3, 300-311  
**Volta, experiments on contact electri-**  
 city, 5, 50-51  
**Voltage,**  
 arc length, and, 3, 98-99  
 cells, source of, in, 9, 405-408  
 colour in glow discharges, and, 6,  
 167-180  
 gradient in flames, 1, 113-114, 7, 2  
 high, 3, 91-120  
 lightning, of, 3, 100  
 oscillating, physiological effect, 4,  
 334  
 striations, in, 7, 370  
**Voltaic,**  
 action, origin, 5, 563  
 battery discovery, 5, 53  
 cell,  
 demonstration, 5, 53-55  
 low temperature, at, 5, 465  
 source of voltage, 9, 405-408  
 pile, 2, 75-78  
 discovery, 3, 268  
 theory, 2, 75-78  
**Voltameter,** 3, 94  
**Voltmeter,** 6, 376  
 Cardew, 4, 333  
**Volume,**  
 atomic, 4, 4, 5, 213, 7, 336 337, 8,  
 325  
 change on,  
 dissociation, 6, 102  
 freezing, 7, 17  
 neutralisation, 6, 102  
 combining, 1, 549-554  
 critical, 2, 294-301, 3, 314-317  
 elasticity, 8, 346-362  
 liquids, of, 7, 169  
 molecular, 2, 480-481; 7, 336  
 at absolute zero, 6, 8-9  
 of paraffins, 7, 133  
 partial molar, 4, 4  
 theory of atomic, 8, 131  
 valency, 7, 337, 8, 323  
**Vorpumpe,** 9, 237  
**Vortex,**  
 atoms, 6, 371  
**Vortex—cont**  
 mirror, 10, 180  
 motion, 2, 510-511  
 theory, 7, 438  
 of the aether, 4, 394  
 work of Helmholtz, 4, 394  
**Vortices,** 5, 215, 10, 178-200  
 earth's rotation, and, 10, 187-190  
 Kundt's tube, in, 9, 311  
 soap solution, in, 8, 414-423  
**Voss machine,** 3, 469, 4, 342  
**Vulcanite,** 4, 94
- W**
- Wagnerite,** 5, 85  
 chlorine analogue, 5, 85  
**Wall, sound transmission,** 8, 369  
**Wallflowers,** 9, 116  
**Warmth of clothing,** 2, 275-281  
**Wasp sting,** 4, 186  
**Watches,** 5, 451  
**Water,** 1, 328  
 absorption,  
 ammonia, of, 2, 237  
 bubbles, by, 8, 89-99  
 clothing, by, 2, 278  
 palladium, by, 2, 47  
 action of,  
 aluminium and iodine, 2, 499  
 chlorine, 2, 149  
 fluorine, 5, 96  
 silicon halides, 7, 57  
 adsorption on sodium chloride, 1,  
 424-425  
 alcohol,  
 diffusion through rubber, 7, 485-  
 486  
 foam, 4, 26  
 allotropy, 7, 23  
 atmosphere, in, 1, 494  
 aurora, effect on, 6, 419  
 ball motion in, 2, 515-517  
 boiling, 1, 131-133, 467-474, 7, 413,  
 419-420  
 by hysteresis, 4, 514-515  
 bolt, 9, 237  
 Brewster's angle, 2, 170  
 bulk modulus, 8, 346-348  
 bumping, 1, 467-474

**Water—*cont***

- calorimeter, 5, 189–191
- camphor on, 6, 15
- capillary action, 1, 131, 6, 15–16
- carbon disulphide surface, 3, 332
- carbon monoxide combustion, effect on, 8, 468
- catalytic effects, 7, 100–103
- cell for heat insulation, 7, 80
- chalk districts, from, 2, 262–264
- chemical reaction, effect on, 6, 419
- clay, on, 10, 295–298
- coal, from, 1, 399, 9, 336–340
- coherence, 8, 347
- colour, 2, 254–264, 6, 416–417
- colours, 9, 261
- compressibility, 5, 143–146
- condensation nuclei, 6, 62–66
- conductivity, 5, 493
- constitution, 2, 494–495
- cooling in vacuum flask, 7, 389
- critical,
  - constants, 3, 315
  - point, 5, 361
- crystallisation, of, 2, 519–520, 8, 330
- decomposition by zinc-copper couple, 2, 439–440, 497
- degassing, 1, 467–474
- degree of ionisation, 6, 102
- density, 6, 3
- diamagnetism, 1, 67–69
- dielectric constant, 6, 419
- diffusion,
  - ammonia, through, 2, 42–44
  - rubber, through, 7, 483–486
  - salts in, 1, 393–396
- dispersion, 3, 245–246
- dissociation, 3, 380–386, 6, 96
  - at high temperature, 7, 416
- drinking, 2, 260–264
- drops,
  - charged, 1, 171, 5, 560
  - terminal velocity, 5, 406
  - vibration, 3, 331
- electrical,
  - conductance, 1, 166–172
- discharge to, 1, 32
- electrolysis, 1, 98, 2, 72, 494, 5, 485, 8, 343, 10, 18, 49
- electrolytic character, 5, 493
- ether distribution, 5, 527

**Water—*cont***

- evaporation rate, 7, 494
- expansion on freezing, 7, 17
- fatty acid film on, 9, 40, 44
- filled telescope, 4, 194, 200
- flatness of surface, 4, 244
- form of flowing, 3, 95–96
- formula, 1, 154–155, 445–455
- freezing,
  - depression, 2, 523
  - point and pressure, 1, 181, 7, 17
  - refrigeration, by, 5, 361
- friction in tubes, 4, 2–3
- gas, 6, 233
  - calorific value, 7, 416
  - process, 9, 353
- gelatinisation of, 2, 520
- gravitational effects, 5, 305
- hardness, 2, 262–264
- heat of formation, 2, 149
- heated surface on a, 1, 49–50
- heavy (*see Deuterium oxide*)
- hydrogen peroxide from, 5, 261
- ice phases, 6, 427
- infrared,
  - absorption, 1, 493, 531, 8, 273, 289
  - spectrum, 3, 212–214, 9, 228
- internal motion, 3, 290–299
- isotherms, 4, 106–108
- jet, 1, 131–133
  - ball on, 5, 278
  - oscillations, 4, 34–35
  - photography, 4, 61–64
  - Tyndall's work, 4, 273–274
- latent heat of,
  - evaporation, 2, 400
  - fusion, 6, 33–34
- liquid air on, 6, 211
- London, supply to, 2, 264
- loss by plants, 2, 402
- magnetism, effect on, 1, 66
- masses, effect on climate, 2, 276
- maximum density, 4, 4, 5, 143
- micelles, in, 9, 68
- microwave absorption, 5, 17
- minimum compressibility, 5, 145–146
- molecular,
  - structure, 1, 402, 445–455, 555, 9, 503
  - volume, 6, 8–9

**Water—cont**

- motion, 1, 131–133, 3, 290–299
  - in river, 5, 215
  - of disc in, 2 513–517
- non-laminar flow, 3, 295–297
- oil film on, 3, 298, 4, 28–34, 9, 40, 110–112
- oleic acid film on, 9, 111–112
- particles in, 2, 254–264
- phases, 6, 247, 7, 23
- phosphorescence, 4, 377
- pressure and viscosity, 5, 143
- pure, 2, 261
- purification, 1, 467–474
  - by charcoal, 6, 395
- rate of evaporation, 2, 401
- reflection,
  - in stream of, 1, 132–133
  - of Hertz waves, 4, 346
- refractive index, 3, 245–246
- rigidity, 8, 346
- salt eutectics, 2, 522
  - phase diagrams, 2, 523
- sand firmness, effect on, 3, 356
- scattering of light, 2, 254–256, 261
- softening, 2, 262–264
- solubility of,
  - ammonia, 2, 246
  - argon, 4, 466
  - helium, 4, 455–456
- specific heat, 1, 253 254
- spectrum, 3, 199–200, 7, 358
- spherical drops, 1, 49
- spheroidal state, 2, 294
- splashes, 4, 291–320
- spreading of films on, 10, 417–427
- sterilisation, 7, 378
- structure, 5, 143–146, 6, 426–428
- supercooling, 1, 135
- superheavy, 10, 68
- supersaturation of vapour, 4, 111, 6, 62
- surface,
  - tension, 4, 31–32, 118
  - viscosity, 4, 36
- temperature, at low, 6, 426–428
- thermal decomposition, 2, 149–150
- theory, 6, 426–428
- transpiration from plants, 5, 372–373
- turacin, in, 4, 239

**Water—cont**

- ultraviolet,
  - absorption, 1, 429–431
  - spectrum, 3, 260, 264–265
- vapour,
  - adsorption on charcoal, 6, 106
  - atmosphere, in, 1, 422
    - effect on climate, 3, 275–280
  - diffusion,
    - apertures, through, 5, 379–390
    - flames, in, 5, 198–199
    - rubber, through, 7, 471
  - flame velocity, effect on, 4, 146
  - light scattering, 9, 274
  - liquefaction by pressure, 4, 106
  - p,V,T data, 4, 106–109
  - pressure, 7, 494
    - freezing point, and, 7, 8–9
    - temperature, and, 2, 399 400
  - sounding, 3, 153–157
  - supersaturation, 4, 111, 6 62
- velocity of,
  - light in, 2, 10
  - in flowing, 4, 198
  - waves, 5, 326–327
- vibrationally excited, 8, 468–469
- viscosity, 2, 212 213, 5, 141–149, 9, 168
  - alcohol, effect of, 7, 440
  - pressure, and, 5, 143–145
  - salt, effect of, 5, 146
  - solutions of, 2, 212–213
  - temperature, and, 2, 213, 5 143 144
- voltmeter, 3, 94
- vortices, 2, 514
- X-ray transparency, 4, 488
- zero-point energy, 10, 55
- Waterfalls, 5, 560
- Waterspouts, 10, 190–192
- Wave, 4, 248–249
  - aether, in, 4, 321–349
  - carrier, 10, 405–413
  - demonstration model, 3, 230–231
  - electric, 5, 369–371
  - electromagnetic, 4, 321–349
    - predicted properties, 4, 324
  - short, 5, 14–26
  - explosion, 4, 143, 6, 300, 9, 469–494
    - velocity of, 6, 301
  - function, 9, 202–204

**Wave—cont**

- group velocity, 9, 207
  - Hertzian, 4, 18–25
    - optical properties, 4, 345–348
    - screening, 4, 99
  - mechanical nature of,
    - electrons, 9, 190–192, 204–213
    - X-rays, 7, 348, 8, 60
  - mechanics, 9, 183, 202–204
  - medium, moving, in, 4, 194
  - 30 metre, 4, 330
  - motion, 4, 322–323
    - demonstration, 5, 11–12
    - source, and, 4, 190
  - packet, 9, 375–385
  - sea, 2, 292–293, 411–412
    - effect of oil, 4, 32–33
  - seismic, 8, 292
  - shock in,
    - flames, 9, 479–481
    - photography, of, 5, 326
  - stationary, 2, 22
    - of sound, 9, 285–289
  - study by Faraday, 4, 155–156
  - theory, 1, 5, 6, 42, 48, 257, 2, 7, 12, 3, 123, 227–256, 454, 462, 8, 510–515, 9, 4–5
    - shadows, of, 3, 463–464
    - sound, of, 3, 123
    - X-rays, of, 9, 4–5
    - Young's work, 5, 278
  - transverse, 3, 230
  - water, in, 7, 431
    - velocity, 5, 326–327
- Wavelength**
- cathode rays, of, 9, 207–213, 358
  - de Broglie, 9, 207–213, 358
  - determination, 3, 247
  - heat rays, of, 1, 42–48
  - light, of, 1, 42–48
    - frequency of, 3, 229
    - scattering, and, 9, 274
  - radiation and temperature, of, 1, 46
  - refractive index, and, 1, 45
  - sound, of, 3, 454–465
  - velocity, 5, 326–337
  - water, 7, 431
  - X-rays, of, 7, 345–349, 447–454
- Wax,**
- magnetism, 1, 68
  - phosphorescence, 7, 81

**Weak acids, 6, 96****Web, spiders, 3, 565–568****Weber's,**

- radiation law, 5, 237–240
- theory of magnetism, 4, 128

**Wedekind reaction, 9, 219****Wehnelt cathode, 7, 488****Weight,**

- atomic, 1, 500–508
- earth, of, 4, 353
- heat, of, 2, 276–281
- molecular, 2, 480–481
- specific, 6, 98

**Welshbach mantle, 5, 393****Werner's hypothesis, 5, 195–196****Wetting of glass, 3, 346****Whale oil, 9, 98****Wheat,**

- production 1906, 6, 181
- yield, 6, 181

**Wheatstone,**

- bridge, 2, 348, 3, 320, 4, 520–521
- reciprocity, 6, 59

**Whimshurst machine, 3, 466–471, 4, 342****Whirlpools, 5, 215, 10, 187–200****Whirlwind, 4, 248–249****Whispering,**

- gallery, 6, 60–61
- model, 9, 288

**Whistle, effect on flames, 2, 33–35****Whistling wind, 7, 437****White,**

- heat, 7, 238
- lead, 1, 332
- mica, 8, 289

**Whitworth,**

- measuring machine, 4, 444, 5, 556
- standard bars, 4, 363

**Widdington's law, 8, 57****Width of spectral lines, 8, 236–243****Wiedemann rays, 4, 502****Wien's law, 8, 240, 277–238****Wild,**

- mallow, 9, 115
- purple larkspur, 9, 115

**Willemite, 6, 213****Wilson cloud chamber, 5, 406, 7, 312–324, 9, 187–188**

- cosmic rays in, 10, 35–38
- neutron in, 9, 416

- Wind,**  
 aiming, and, 4, 189  
 cross, 7, 117-118  
 electrical, 4, 494  
 gauges, 5, 451  
 pressure, 5, 448-450  
 pitch, effect on, 4, 196  
 sun's radiation, and, 1, 319  
 whistling, 7, 437  
**Window-glass,** 9, 157  
 purpled, 9, 164  
**Windrows,** 9, 112  
**Wine,**  
 -glass, bowed 5, 481  
 photographic plate, action on, 5, 259  
 tears, 3, 347-348  
**Wings,**  
 bee, 4, 186  
 bird, 5, 294  
**Wintergreen,** oil of, 2, 195, 274  
**Wire,**  
 electrical fusion, 1, 366  
 frames for bubbles, 8, 159-162  
 -grid polariser, 4, 348, 5, 20-22  
 ice, 6, 4  
 insulation, 1, 96 97  
**Wireless,**  
 telegraphy, 5, 235, 7, 291  
 transatlantic, 7, 280-281  
 transmission, 10, 405-413  
**Wiring of ships,** 4, 97  
**Woad,** 3, 159  
**Wohler's synthesis,** 1, 270-271  
**Wolf-Raynet stars,** 8, 40, 371  
**Wood,**  
 burnt by infrared, 1, 532  
 chemiluminescence of decaying, 4, 507  
 conduction of heat, 1, 78-79  
 destructive distillation, 2, 195, 3, 29  
 electrostatic screening, 4, 94  
 glowing, action of liquid oxygen, 4, 233  
 heating power, 2, 276  
 -naphtha, 3, 163  
 photographic plate, action on, 5, 259  
 sois, 9, 67  
 spirt, 2, 195  
 ultraviolet absorption, 1, 430-431  
 staining, 10, 118  
 X-ray transparency, 4, 487  
**Woodpeckers,** 4, 237  
**Woodruff,** 6, 12  
 fragrance, 2, 146-147  
**Wood's metal,**  
 breaking stress, 4, 269  
 photographic plate, action on, 2, 258  
 rigidity, 4, 270  
 thermal conductivity, 6, 213  
**Wool,**  
 asparagine in, 9, 250  
 bleaching by chlorine, 2, 266  
 dyeing, 1, 410, 9, 22  
 heat insulations 2, 277  
 water absorption, 2, 278  
 X-ray diffraction, 9, 454  
**Work,**  
 chemical processes, from, 2, 422  
 copper, hardening of, 9, 2-3  
 crystal structure, hardening and, 9, 2-3  
 energy, and, 1, 370-380  
 heat, and, 1, 181-183, 196-201, 235, 372-373, 2, 77  
 function, 6, 361-366  
 gases, done by, 4, 111-112  
 liquid films, done in stretching, 3, 236-237  
 physiological, 1, 417-421  
 surface tension, and, 10, 4  
**World-line,** 8, 186-197  
**Wiaten panchromatic plates,** 10, 131

## X

- X-ray,**  
 absorption, 8, 47-55  
 atomic weight, and, 4, 487  
 density, and, 4, 487  
 collimation, 7, 343  
 detector, 7, 449  
 diffraction, 7, 340-354, 445-454, 8, 318, 9, 1-3, 214-216, 245-260, 10, 210-226  
 acoustic analogy, 7, 448  
 alloys, of, 9, 214-215  
 atoms, use of heavy, 9, 78  
 biological molecules, of, 9, 446-464  
 bismuth, of, 9, 151-152  
 Bragg theory, 7, 447-448  
 clays, of, 10, 286-330

**X-ray—cont.****diffraction—cont.**

- colloids, of, 9, 67
- diamond, of, 7, 453
- fluorescent screen, with, 7, 353
- inorganic crystals, of, 9, 77–87
- intensity, 7, 452–453
- liquid crystals, of, 9, 516, 536
- liquids, of, 9, 323–324
- magne-crystals, of, 9, 131–154
- magnets, of, 10, 461
- metals, of, 9, 2
  - fatigue, and, 10, 225–226
- organic crystals, of, 9, 40–47
- powder method, 8, 318–320
- proteins, of, 10, 433–445
- silicates, of, 10, 271–280
- temperature, and, 9, 258
- theory, 7, 345–347
- thin films, of, 3, 34–47
- tobacco mosaic virus, of, 10, 223
- fluorescence, 4, 485; 7, 324; 8, 58
- spectrometer, 7, 449; 8, 58, 318; 9, 4–5, 189–190, 230–231
- tube,
  - design, 5, 111–120
  - voltage and penetration, 8, 47–55

**X-rays, 4, 485–510; 5, 109–134; 7, 154–163; 8, 56–65**

- actinic properties, 4, 488
- astigmatism, 5, 119–120
- atomic,
  - number, 8, 132
  - structure, 7, 451
  - weight, 5, 465
- brush discharge, effect on, 4, 503
- cathode material, effect of, 5, 112
- size, 5, 111–112
- characteristic, 7, 451, 505–506; 8, 58
- chemical action, 7, 101
- cloud,
  - chamber, in, 7, 319–324
  - formation, 6, 63–66
- collimation, 7, 343
- coloration of glass, 9, 164
- corpuscular theory, 9, 4–5
- demonstration, 4, 486
- detection of soft, 7, 489
- discharge of bodies by, 4, 501
- discovery, 4, 485, 500

**X-rays—cont.**

- distribution of scattered, 8, 60
- divergence, 7, 347
- electrons, and, 7, 506–507
- elliptical spots, 7, 347
- fluorspar, effect on, 4, 508–509
- genesis, 8, 47–55
- gas ionisation, 6, 17–23; 7, 406
- internal reflection, 7, 349
- JKLM radiations, 8, 61–65
- low-temperature absorption, 5, 160
- nature, 7, 348
- nuclear charge, and, 9, 6–16
- optical properties, 7, 445–446
- origin, 4, 503; 5, 409; 7, 491; 8, 47–55
- $\beta$ -particles from, 7, 312
- periodicity and, 7, 452
- photoelectric effect, 6, 170; 7, 312; 9, 182–192
- photography, 4, 485–510
  - of source, 5, 120–122
- polarisation, 4, 488, 509; 7, 446
  - of scattered, 8, 60
- properties, 4, 500–502
- quantum effect, 7, 446, 508–509; 8, 60; 9, 4–5
- $\gamma$ -rays, and, 5, 521; 6, 282; 7, 501
- reflection, 4, 488; 7, 343
- refraction, 4, 488
- scattering,
  - air, by, 4, 488
  - electrons, by, 8, 88
  - factor, 7, 452–453; 8, 58
- secondary, 8, 58
- soft, 7, 487–491
- softening, 7, 189–190
- spectra of isotopes, 8, 114
- tantalum electrodes, 7, 51
- theory, 5, 122–124
- ultraviolet light, and, 4, 500
- velocity of electrons ejected by, 8, 54–55, 57, 61
- wave,
  - character, 8, 60
  - theory, 9, 4–5
- wavelength, 7, 345–347, 447–454; 9, 224
- zinc, action on, 7, 345

**Xanthophyll, 9, 114**

- formula, 10, 228



**Xanthophyll—cont**

leaf, 10, 234

occurrence, 10, 228

vitamin A, and, 8, 375–376

**Xenocyanine, 10, 137****Xenon,**

air, in, 5, 466–467, 6, 435

argon ratio, 7, 462

atomic,

radius, 8, 329

spectrum, 5, 470

weight, 5, 467, 7, 71, 8, 340, 9, 7

boiling point, 7, 71

discovery, 5, 466–467

glow discharge, 5, 468

isolation, 6, 228

isotopes, 8, 336–340

krypton ratio, 7, 462

mass,

charge ratio, 7, 295

spectrum, 8, 336–340

melting point, 7, 141

**Xerophthalina, 10, 237****Xenotime, 4, 53, 3, 410****Xylene,**

coal, from, 1, 399

1 ton coal, 3, 365–366

dyes, 3, 368

infrared transmission, 8, 285

red, 7, 378

viscosity, 5, 142–154

**Xylidine,**

from 1 ton coal, 3, 365–366

infrared transmission, 8, 287

scarlet, 3, 368

**Y****Yard, definition, 5, 450****Yeast,**

phosphorescence, 7, 81

spectrum, 7, 82

**Yield of wheat, 6, 181****Yellow quartz, 9, 165****Yolk of egg, 10, 228****Young, 5, 277–279**

calculation of molecular size, 5, 278

colour vision theory, 5, 126–134

concept of energy, 5, 277

heat, views on, 5, 279

**Young—cont**

wave theory, 5, 278

work on,

astigmatism, 5, 278

ball on jet, 5, 278

colours, 5, 278

elasticity, 5, 277–278

eye, 5, 278

forced vibrations, 5, 278

heat and work, 4, 2

optics, 5, 278

sound, 5, 278

tides, 5, 278

**Young's modulus,**

definition, 8, 350

low temperature, at, 4, 266–270

melting point, and, 8, 355

temperature, and, 8, 352–355, 464

**Yttria, 3, 405–415**

in furnace, 7, 240

**Yttrium, 1, 357**

atomic,

refraction, 2, 541

weight, 1, 500–508, 2, 541

discovery, 2, 316–317

history, 3, 409

separation, 8, 451

**Z****Zeaxanthin, 10, 231–244**

chromatography, 10, 231

**Zeeman,**

effect, 5, 49, 264–276, 565–567, 6, 190–209

electric, 8, 239

in hydrogen, 8, 33

theory, 5, 267–268

polarisation, 5, 268

**Zelinder's trigger tube, 4, 332, 341****Zenith, 5, 297****Zeolites, 10, 298****Zero,**

absolute, 6, 381–390

approach to, 4, 161, 223, 5, 459, 10, 71–98

conductance at, 4, 529–530

molecular volumes at, 6, 8–9

point energy, 10, 49–67

of helium, 10, 463

**Zinc,**

- action current, 5, 427-438
  - bacteria, on, 7, 86-92
  - ethyl iodide, on, 1, 90-93
  - gold chloride, on, 2, 337-338
  - photographic plate, on, 5, 257-258
  - X-rays, on, 7, 343

ammonium sulphate, 7, 352

amyl, 1, 139

atomic,

- heat, 5, 190; 7, 401
- radius, 8, 326; 9, 502
- refraction, 2, 541
- spectrum, 1, 384; 3, 134
- volume, 7, 401
- weight, 1, 500-508, 535; 2, 325, 541

blende, 1, 510

- cleavage, 4, 120
- structure, 7, 331; 8, 318, 321-325; 9, 450-451

thermoelectricity, 9, 450

X-ray diffraction, 7, 340-354

boiling point, 7, 237

breaking stress, 4, 269

and temperature, 5, 462-464

bromoethoxide, 2, 440, 498

bronzes, in, 9, 214

carbonate,

- artificial photosynthesis, in, 9, 195
- basic, 1, 332
- crystal structure, 8, 323-325

cells, use in, 3, 91

chemical properties, 1, 570

chloride,

- alcohol of crystallisation, 2, 209
- electrolysis, 5, 553
- heat of formation, 2, 149

chloroethoxide, 2, 441, 498

copper,

- contact electricity, 3, 233; 5, 50-83
- couple, 2, 439-441, 497-499

crystals, dissolving in copper, 10, 248-250

diallyl, 2, 440

diamyl, 1, 518-522

synthesis, 2, 440, 498

diethyl, 1, 528

synthetic use, 1, 518-522

diffusion into copper, 10, 248-250

diisopropyl synthesis, 2, 440, 498

**Zinc—cont.**

dimethyl, 1, 518-522

dipropyl, 2, 440, 498

discovery, 2, 315-316

double sulphates, 5, 540

electropositivity, 5, 563

emissivity, 8, 290

equivalent weight, 5, 553

ethiodide synthesis, 2, 439-440, 498

ethyl, 1, 92-93, 273

decomposition, 1, 452

iodide, 2, 439

synthesis, 2, 146

foil, burnt by infrared, 1, 533

formation of X-rays, 4, 504

glance, 1, 331

gold couple, 2, 497

gravitational effects, 5, 305

heat of alloying with copper, 5, 71-73

hydrogen peroxide from, 5, 261

iodoethoxide, 2, 498

ionic radius, 9, 86

lead thermocouple, 4, 538

lithio-,

ethyl, 1, 518-522

methyl, 1, 518-522

magnetism, 1, 68

melting point, 7, 237

methyl, 1, 139

molecular structure, 9, 504

mutual inductance, effect on, 3, 304

nitrate, 2, 210

organic compounds, 1, 518-522

oxide-,

crystal structure, 7, 130; 8, 323-325

film, 5, 56

glass, in, 9, 161

infrared absorption, 2, 5

reduction, 2, 150

ultraviolet photography, 7, 205

permanganate, 6, 100

platinum,

couple, 2, 497

thermocouple, 4, 540

potassium sulphate, 2, 210

production, 1, 286

propiodide, 2, 440, 498

propyl, 2, 498

rate of discharge, 6, 21

**Zinc—*cont.***

- resistance and temperature, 4, 524–527; 5, 459
- rigidity, 8, 360
- screening by, 4, 100
- silicate, 1, 331
- silver, alloy, 5, 192
- specific heat, 2, 325; 5, 190
- sulphate,
  - hydration, 2, 209–210
  - seeding by, 3, 398
  - solution conductivity, 6, 93–95
  - surface properties, 3, 333–337
  - water eutectic, 2, 522
- sulphide,
  - crystal structure, 7, 130, 331, 337; 8, 318, 321–325
  - radioluminescence, 6, 41
  - scintillation counter, 8, 521
- sun absence from, 1, 359
- surface tension of liquid, 4, 118
- trace in explosion, 3, 445–450
- ultraviolet spectrum, 3, 259, 264–266
- X-ray transparency, 4, 488
- Young's modulus, 8, 354–355
- Zeeman effect, 5, 273–274; 6, 190, 208

**Zincate, potassium, 1, 155**

- Zirconia, 7, 29
  - furnace, in, 7, 240
  - pottery, 7, 241
- Zirconium,
  - abundance, 10, 272
  - atomic,
    - heat, 7, 401
    - refraction, 2, 541
    - volume, 7, 401
    - weight, 1, 500–508; 2, 541
  - boride, 9, 424
  - carbide, 9, 424
  - discovery, 2, 316–317
  - nitride, 9, 424
  - silicide, 9, 424
- Zircons, 4, 53
  - effect of heat, 9, 165
- Zodiac, 1, 120
- Zonal growths, 7, 328
- Zone-plate, 4, 347
- Zoned crystals, 4, 51–57
- Zones,
  - Huygen's, 3, 461; 5, 478
  - law of conservation, 1, 297
- Zymase, 6, 36–37
  - d-glucose, fermentation, 6, 37
  - phosphorescence, 7, 81